Comprehensive Assessment and Monitoring Program

Assessment of Anadromous Fish Production in the Central Valley of California between 1992 and 2016

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ACRONYMS AND ABBREVIATIONS

AFRP Anadromous Fish Restoration Program

CAMP Comprehensive Assessment and Monitoring Program

CDFW California Department of Fish and Wildlife

CVPIA Central Valley Project Improvement Act

FMWT Fall Midwater Trawl

PMFC Pacific Fishery Management Council

USFWS U.S. Fish and Wildlife Service

YOY young-of-the-year

TAXA refers to different species of anadromous fish or different runs of Chinook Salmon

BASELINE PERIOD reflect the years between 1967 and 1991

POST-BASELINE reflect the years between 1992 and 2016

MISCELLANEOUS CREEKS are considered to be a single watershed

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EXECUTIVE SUMMARY

This Comprehensive Assessment and Monitoring Program (CAMP) annual report compiles and synthesizes anadromous fish production data from the Central Valley of California between 1992 and 2016. These data are then used to assess overall (cumulative) effectiveness of habitat restoration actions implemented pursuant to Section 3406(b) of the Central Valley Project Improvement Act (CVPIA) in meeting fish production targets developed by the Anadromous Fish Restoration Program (AFRP). To accomplish these tasks, this report quantifies the natural (as compared to hatchery) production of eight anadromous fish taxa in one broader area and 22 Central Valley watersheds where AFRP fish production targets exist. The eight fish taxa include Fall, Late-fall, Winter, and Spring-run Chinook Salmon; Striped Bass; American Shad; White Sturgeon; and Green Sturgeon. Monitoring data for White and Green Sturgeon in San Pablo and Suisun bays are available only for eleven years between 1992 and 2009. Monitoring data for legal-size Striped Bass in the Central Valley's anadromous waters are available in 16 years between 1992 and 2012. The broader area includes San Pablo Bay,Suisun Bay, and the Sacramento-San Joaquin River Delta. The 22 watersheds are the American River, Antelope Creek, Battle Creek, Bear River, Big Chico Creek, Butte Creek, Calaveras River, Clear Creek, Cosumnes River, Cottonwood Creek, Cow Creek, Deer Creek, Feather River, Merced River, Mill Creek, seven "Miscellaneous creeks", and the Sacramento River mainstem up- and downstream of the former site of the Red Bluff Diversion Dam, Mokelumne River, Paynes Creek,Stanislaus River, Tuolumne River, and Yuba River. The CAMP cannot assess progress toward the AFRP's Steelhead production target because comparable monitoring data for this taxon before and after 1994 have not been collected due to operational changes at the Red Bluff Diversion Dam on the Sacramento River.

The AFRP production targets for Chinook Salmon consist of three tiers that include:

- Watershed-specific production targets for different locations and runs of Chinook Salmon,
    - A run-specific production target for each of the four runs of Chinook Salmon in the Central Valley, and
    - A Central Valley-wide production target for the combined total of all four runs of Chinook Salmon. The production targets for White and Green Sturgeon, American Shad, and Striped Bass only consist of one tier in the Central Valley.

Chinook Salmon data presented in this report demonstrate that:

- The production of adult Fall-run Chinook Salmon steadily rose in each of the years from 2010 to 2013, then declined in 2015 to 149,033 salmon. This suggests a steady rebuilding of that salmon stock following the marked decline that occurred between 2004 and 2009, and a two-year reversal in the recovery of that salmon stock in the two most recent years.
- As the production of adult Fall-run Chinook Salmon increased between 2010 and 2013, the combined production of all four runs of adult Chinook Salmon Central Valley-wide also increased because Fall-run Chinook Salmon predominate in their contribution to the Central Valley total. Similarly, the combined production of all four runs of adult Chinook Salmon declined in 2015 due to drought, largely because the all runs production is heavily influenced by the Fall-run Chinook Salmon production. Fish leaving the system in 2013-2014 (drought years) returned in 2015-2016 as adults but in low numbers because of poor early life survival. In 2016, the combined Central Valley-wide adult production of all four salmon runs was 160,466 salmon, vs. 41,381 salmon in 2009.
- A collection of generalized linear and additive models were developed to study changes in mean values pre- and post-1992 In general, the patterns and analyses suggest that while there is significant change in the characterizations of the return distributions pre- and post-1992, they are not simple (e.g. as might be captured in an overall mean). Based on a log-linear model allowing a change beginning in 1992, only Fall pre 1992 and Winter post-1992 have shown positive trends through time, and in all other cases the trend beginning in 1992 has grown more negative, although not always significantly.
- The use of a Cormack-Jolly-Seber mark recapture model during adult Chinook Salmon escapement surveys in the past three years in some watersheds is beginning to produce data that will provide a more statistically robust approach to assessing long-term trends in the production of adult salmon.
- The presence of fish hatcheries in several watersheds confounds the ability to accurately assess natural salmon production because the proportions of natural vs. hatchery origin salmon needed to calculate natural production for different salmon runs and watersheds in 2016 are not currently available.

During the 25-year period between 1992 and 2016:

- The watershed-specific AFRP Spring-run Chinook Salmon production target was met 21 times on Butte Creek in the post-baseline period. The other three watersheds with a Spring-run Chinook Salmon target (Deer Creek, Mill Creek, and the Sacramento River mainstem) have never met their AFRP targets in the post-baseline period.
- The watershed-specific AFRP Late-fall-run Chinook Salmon production target for Battle Creek was met 17 times in the post-baseline period, and the Sacramento River mainstem only met its AFRP Late-fall-run Chinook Salmon target once in the 24 years when monitoring data were collected for this run and watershed.
- The watershed-specific AFRP Fall-run Chinook Salmon production targets were met 6 or more times in five of the 21 watersheds with a fall-run target. These watersheds are: American River, Battle Creek, Butte Creek, Clear Creek, and the Mokelumne River. The watershed-specific AFRP Fall-run Chinook Salmon production target for the Feather River was met four times. The remaining 15 watersheds with a Fall-run Chinook Salmon production target have: (a) met their production targets less than three times during the 25-year post-baseline period, or (b) were not surveyed each year since 1991.

- The watershed-specific AFRP Winter-run Chinook Salmon production target for the Sacramento River mainstem was never met during the post-baseline period, and the Calaveras River did not meet its AFRP Winter-run Chinook Salmon target in the five years surveys were conducted.
- Run-specific AFRP production targets for Fall, Winter, and Spring-run Chinook Salmon were never met in the post-baseline period, and the run-specific AFRP production target for Late-fall-run Chinook Salmon was met once in 1998.
- The Central Valley-wide AFRP production target for the combined total of all four runs of Chinook Salmon from 22 watersheds was never met in the post-baseline period.

Results for non-salmonid species were as follows:

- The Fall Midwater Trawl index for juvenile American Shad in the Sacramento-San Joaquin River Delta and San Pablo and Suisun bays suggests the AFRP production target for this species was met in three of 25 years between 1992 and 2016. The 2016 index for this species is 313.

1 INTRODUCTION

1.1 Overview of the CVPIA, AFRP, and CAMP

The CVPIA was authorized in October 1992 (Public Law 102-575, Title 34), and amends the authority of the Central Valley Project to include fish and wildlife protection, restoration, and mitigation activities as having equal priority with other Central Valley Project functions. Section 3406(b)(1) of the CVPIA directs the Secretary of the Interior to ".implement a program which makes all reasonable efforts to ensure that, by the year 2002, natural production of anadromous fish in Central Valley rivers and streams will be sustainable, on a long-term basis, at levels not less than twice the average levels attained during the period of 1967-1991." The CVPIA defines natural production as "fish produced to adulthood without direct human intervention in the spawning, rearing, or migration processes." The CAMP annual reports adopt that emphasis, and therefore quantify the natural (as compared to hatchery) production of anadromous fish taxa. Pursuant to Section 3406(b)(1) of the CVPIA, the AFRP was established to restore anadromous fish populations through a variety of management strategies. The CAMP was established pursuant to CVPIA section 3406(b)(16) to ".monitor fish and wildlife resources in the Central Valley to assess the biological results and effectiveness of actions implemented pursuant to subsection [3406(b)]".

In 1994, the California Department of Fish and Wildlife (CDFW) issued a report that quantified abundance of fish taxa in the Central Valley between 1967 and 1991 [Mills, T.J., and R. Fisher, 1994] (Table 1). The AFRP used the CDFW fish abundance estimates to develop production targets for nine anadromous fish taxa in one broader area and 22 watersheds in the Central Valley. The AFRP production targets are twice the average levels during the 1967-1991 baseline period and are quantified in the Final Restoration Plan for the Anadromous Fish Restoration Program [U.S. Fish and Wildlife Service (USFWS), 2001]. The nine fish taxa include Fall, Late-fall, Winter, and Spring-run Chinook Salmon (*Oncorhynchus tshawytscha*), Steelhead (*Oncorhynchus mykiss*), Striped Bass (*Morone saxatilis*), American Shad (*Alosa sapidissima*), White Sturgeon (*Acipenser transmontanus*), and Green Sturgeon (*Acipenser medirostris*). The broader area includes San Pablo Bay, Suisun Bay, and the Sacramento-San Joaquin River Delta (Bay-Delta), and the 22 watersheds are the American River, Antelope Creek, Battle Creek, Bear River, Big Chico Creek, Butte Creek, Calaveras River, Clear Creek, Cosumnes River, Cottonwood Creek, Cow Creek, Deer Creek, Feather River, Merced River, Mill Creek, seven "Miscellaneous Creeks" upstream of the Red Bluff Diversion Dam on the Sacramento River mainstem, Mokelumne River, Paynes Creek, Sacramento River mainstem, Stanislaus River, Tuolumne River, and Yuba River. To address its mandate, the CAMP produces annual reports that compile and synthesize anadromous fish production

data from the Central Valley. These data are used to assess overall (cumulative) effectiveness of habitat restoration actions implemented pursuant to CVPIA Section 3406(b) in meeting the AFRP fish production targets; the habitat restoration actions include water management modifications, infrastructure modifications, habitat restoration, and fish screens.

This is the 14th CAMP annual report prepared since 1992. Each of the CAMP annual reports is available on the CAMP website.

CAMP annual reports do not estimate production of salmon that originate at fish hatcheries.

1.2 Production Targets for Anadromous Fish Taxa

The AFRP has developed baseline production estimates and fish production targets for each of the nine aforementioned taxa (Table 1 on page 6). With regard to natural production of Chinook Salmon, the AFRP developed three tiers of production targets.

Figure 1 on page 7 provides an illustration that demonstrates how the three tiers of production targets are interrelated. In contrast to the Chinook Salmon production targets, the targets for Striped Bass, American Shad, White Sturgeon, and Green Sturgeon were not tiered and there was only one production target for each of these species.

CAMP annual reports cannot address progress toward the AFRP's Steelhead production target for reasons explained in the 2007 CAMP annual report [U.S. Fish and Wildlife Service (USFWS), 2007]. In short, it is not possible to assess progress toward the AFRP production target for adult Steelhead because operational changes at the Red Bluff Diversion Dam after 1994 preclude the ability to collect comparable post-baseline data for this taxon.

Table 1: Anadromous Fish Restoration Program adult fish production targets. American Shad production targets pertain to juvenile fish. ↕

Taxa	Watershed/area	1967-1991 baseline production estimate	AFRP production target
CHINOOK SALMON			
Fall-run	American River*	80,876	160,000
	Antelope Creek	361	720
	Battle Creek*	5,013	10,000
	Bear River	224	450
	Big Chico Creek	402	800
	Butte Creek	765	1,500
	Clear Creek	3,576	7,100
	Cosumnes River	1,660	3,300
	Cottonwood Creek	2,964	5,900
	Cow Creek	2,330	4,600
	Deer Creek	766	1,500
	Feather River*	86,031	170,000
	Merced River*	9,005	18,000
	Mill Creek	2,118	4,200
	Miscellaneous Creeks	549	1,100
	Mokelumne River*	4,680	9,300
	Paynes Creek	170	330
	Sacramento River mainstem	115,371	230,000
	Stanislaus River	10,868	22,000
	Tuolumne River	18,949	38,000
	Yuba River	33,245	66,000
Late-fall-run	Battle Creek*	273	550
	Sacramento River mainstem	33,941	68,000
Winter-run	Calaveras River[1]	770	2,200
	Sacramento River mainstem*	54,316	110,000
Spring-run	Butte Creek	1,018	2,000
	Deer Creek	3,276	6,500
	Mill Creek	2,202	4,400
	Sacramento River mainstem	29,412	59,000

Table 1: Continued...Anadromous Fish Restoration Program adult fish production targets. American Shad production targets pertain to juvenile fish. ↕

Taxa	Watershed/area	1967-1991 baseline production estimate	AFRP production target
CHINOOK SALMON			
Fall-run	Central Valley	374,049	750,000
Late-fall-run	Central Valley	34,192	68,000
Winter-run	Central Valley	54,439	110,000
Spring-run	Central Valley	34,374	68,000
Central Valley-wide (all 4 salmon runs combined)	Central Valley	497,054	990,000
STEELHEAD	Sacramento River upstream of Red Bluff Diversion Dam	6,546	13,000
STRIPED BASS	Sacramento-San Joaquin River Delta, and the lower portions of the Sacramento and San Joaquin rivers	1,252,259	2,500,00
AMERICAN SHAD[2]	Sacramento-San Joaquin River Delta, San Pablo Bay, and Suisun Bay	2,129	4,300
WHITE STURGEON[3]	San Pablo and Suisun bays	5,571	11,000
GREEN STURGEON[3]	San Pablo and Suisun bays	983	2,000

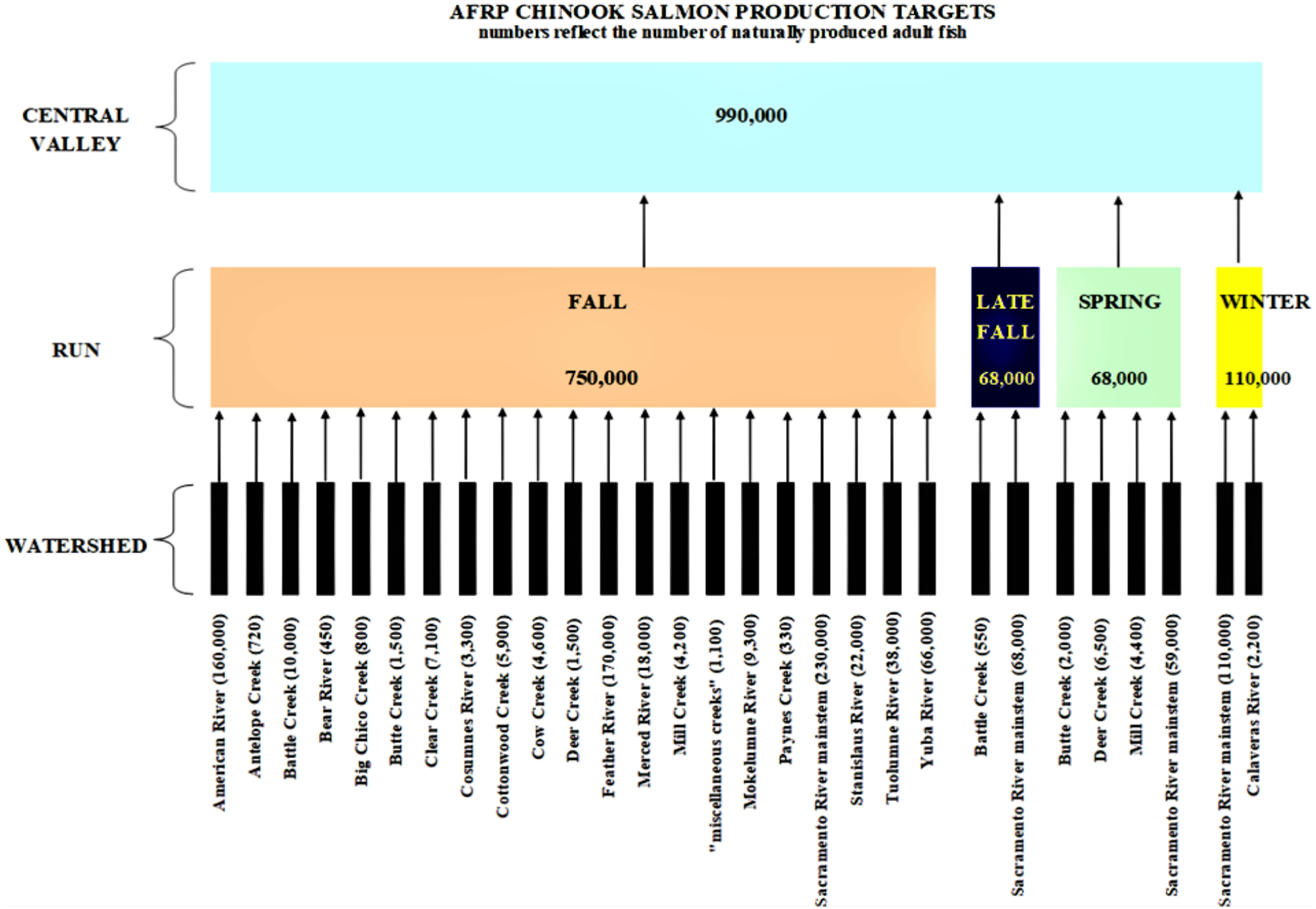
* = Hatchery in the tributary.

1 = Yoshiyama et al. (2001) [Yoshiyama, R.M., E.R. Gerstung, F.W. Fisher and P.B. Moyle, 2001] suggest Winter-run Chinook Salmon may not have existed in the Calaveras River. The putative winter-run fish may actually have been a late-fall-run attracted to the river when flows were released in late winter and spring by New Hogan Dam.

2 = The baseline production estimate and production target for American Shad is based on the Fall Midwater Trawl index for young-of-the-year fish.

3 = The baseline production estimates and production targets for White and Green Sturgeon refer to 15-year old adult fish and fish $\geq$ 40 inches in total length, respectively.

Figure 1: Relationship between the three tiers of AFRP Chinook Salmon production targets.



1.3 Data Caveats

↕ The fish production estimates presented in CAMP annual reports represent the best available information at the time of report production. These estimates are based on digital files maintained by the AFRP and the CDFW. It is important to note that fish production estimates for a given year, location, and taxon frequently differ in different iterations of the CAMP annual reports. These differences arise as the CDFW and AFRP staffs update the digital files used to track fish abundance/production.

Several factors affect the accuracy and/or precision of data and analyses provided in the CAMP annual reports. Some of these factors include, but are not limited to:

1. The CAMP-recommended process for calculating Chinook Salmon production requires an accurate understanding of the relative abundance of natural- vs. hatchery-origin salmon in each watershed. Because the amount of data pertaining to this ratio prior to 2016 is limited, the process of calculating natural production has thus far relied upon best professional judgments of the ratio of natural- vs. hatchery-origin fish in each watershed [U.S. Fish and Wildlife Service (USFWS), 1995]. Potential problems associated with not having definitive data on the ratio are more pronounced for Fall-run Chinook Salmon than other salmon runs because large numbers of fall-run salmon were produced in Central Valley hatcheries prior to 2007 and those salmon were not marked. In contrast, the problem is minimal for Spring, Late-fall, and Winter-run Chinook Salmon because most or all the hatchery-produced fish for these runs have been marked for many years and they are recognizable in the field. The uncertainty pertaining to the hatchery proportion of Fall-run Chinook Salmon should become less pronounced in future years because approximately 25% of these salmon have been marked at Central Valley fish hatcheries since the spring of 2007, and it will gradually become possible to replace the best professional judgments with empirically-based hatchery proportions based on the recovery of marked salmon.

2. The CAMP has not attempted to determine how changes in sampling methods, frequency, or intensity at a given location have changed over time. These changes have the potential to affect fish abundance estimates.

3. The ability of field biologists to assign each salmon to the correct salmon run may introduce a bias that affects salmon production estimates. Agency staff use different criteria, e.g., run timing, to assign Chinook Salmon to particular runs. Some fishery biologists believe the problems with using run timing to identify different runs of Chinook Salmon are relatively small, because other features (e.g., phenotypic differences or spawning condition) also provide clues as to the taxonomic identity of a particular salmon. One research study, however, compared the assignment of individual salmon to a particular salmon run based on the use of genetic markers vs. phenotypic traits and noted there may be large discrepancies between the run assignments using these two techniques [Smith, C.T., A.R. LaGrange, and W.R. Arden, 2009]. At larger scales, these incorrect run assignments may affect the accuracy of the salmon production estimates presented in this report.

4. The CAMP-recommended process for calculating Chinook Salmon production in each watershed should include an estimate of the number of fish harvested downstream of the watershed; i.e., downstream angler harvest. Because harvest of Chinook Salmon between the Pacific Ocean and the Central Valley watersheds has not been consistently monitored (i.e., harvest is frequently not monitored in the Sacramento-San Joaquin River Delta or San Francisco Bay), this harvest may not be accurately accounted for in production estimates for individual watersheds, runs, or the Central Valley as a whole.

5. The CAMP-recommended process for calculating the production of each run of Chinook Salmon in each watershed should include an estimate of the number of salmon harvested in each watershed, i.e., in-river angler harvest. The California Department of Fish and Wildlife has collected angler

harvest data in the Central Valley in 18 of the 25 years between 1992 and 2016. The angler harvest data is not classified according to salmon run, however, thereby making it difficult to directly incorporate CDFW's angler harvest into the database which is used to calculate the salmon production estimates provided in this report. The in-river angler harvest estimates which are reflected in the natural production estimates in this report are therefore based on the best professional judgment of field biologists, and therefore may deviate from actual conditions in the watersheds.

6. The production estimates presented in this report may be subject to future revision as agency staff refine and analyze raw data.

1.4 Acknowledgements

This report would not have been possible without the substantial support of several individuals:

1. Matthew Nobriga and Leo Polansky provided valuable information about the trends in adult salmon return indices statistical analysis.

2. Jason Azat (CDFW) provided a GrandTab spreadsheet with escapement estimates of adult Chinook Salmon.

3. James White (CDFW) provided spreadsheets containing abundance data for juvenile American Shad.

4. The following individuals graciously provided access to population estimates that were developed in different watersheds with a Cormack-Jolly-Seber mark recapture model: Clint Garmin (CDFW), Doug Killam (CDFW), Jeanine Phillips(CDFW), Steve Tsao (CDFW) and Joe Consoli (DWR).

2 METHODS

2.1 Overview of Monitoring Locations and Activities

The watersheds and areas with an AFRP fish production target are depicted in Figure 2. Monitoring techniques used to assess the abundance of anadromous fish vary by taxa and are described in the 1997 CAMP Implementation Plan [Montgomery Watson, 1997]. The techniques include, but are not limited to, carcass surveys, mark-recapture surveys, and ocean harvest surveys. Monitoring activities relating to AFRP fish production targets are focused on adult life stages of Striped Bass, White Sturgeon, Green Sturgeon, and the four runs of Chinook Salmon. Monitoring of American Shad focuses on the juvenile life stage because that is the only reliable long-term data set available for this species.

Every CAMP-recommended monitoring activity in a given watershed may not occur each year. For example, an estimate of the production of adult Fall-run Chinook Salmon from the American River should be quantified using: (1) carcass counts, (2) marking of hatchery-produced salmon to develop a ratio of natural vs. hatchery origin fish, (3) counts of salmon returning to the Nimbus Salmon and Steelhead Hatchery, (4) surveys to quantify in-river angler harvest, and (5) assessments of the harvest of Chinook Salmon in the Pacific Ocean. In reality, estimates of production of salmon from this watershed include census-derived data (e.g., carcass counts, counts of salmon returning to the hatchery, and estimates of ocean harvest) and approximations that reflect best professional judgments (e.g., an estimate of the ratio of natural vs. hatchery origin salmon and the amount of in-river angler harvest).

2.2 Methods for Estimating Production of Adult Chinook Salmon

Calculations to estimate natural production of each run of Chinook Salmon from each watershed include up to four components: (1) in-river spawner abundance (i.e., escapement), (2) hatchery returns, (3) in-river harvest by anglers, and (4) ocean harvest. In-river spawner abundance is quantified using carcass surveys, ladder counts, weir counts, snorkel surveys, and aerial redd counts. Hatchery returns are quantified by counting the number of salmon that enter fish hatcheries; production estimates for watersheds that do not have a fish hatchery will not include this component. Surveys to measure in-river harvest by anglers have not occurred every year since 1992. The amount of in-river harvest used to calculate Chinook Salmon production is therefore based on best professional judgments of angler harvest developed by fishery biologists. Ocean harvest is quantified by monitoring the number of Chinook Salmon captured by commercial and recreational boats; the values are reported by the Pacific Fishery Management Council (PFMC). Because the CAMP has adopted the methods the AFRP used to develop the salmon production targets, the CAMP annual reports use PFMC ocean harvest data that reflect commercial and recreational catches from boats in the Monterey and San Francisco Bay areas (5.2). This report does not therefore reflect ocean harvest of Central Valley Chinook Salmon from boats based in Crescent City, Eureka, and Fort Bragg.

Appendix B (5.2) provides a summary of changes in the angler harvest regulations that have affected adult salmon catch since 2008. In 2008 and 2009, angler harvest of adult salmon from the Central Valley in inland watersheds and Pacific Ocean was temporarily suspended or constrained to promote the recovery of adult Fall-run Chinook Salmon.

Collectively, the sum of the four components is used to estimate the total Chinook Salmon production for a particular salmon run and watershed. To calculate the natural production for a particular salmon run and watershed, the watershed-specific total production estimate for a given run is then multiplied by an estimated hatchery proportion, i.e., the estimated ratio of natural- vs. hatchery-origin salmon of a given run in that watershed. This estimate reflects best professional judgments by fisheries biologists because empirical data for each watershed's hatchery proportion over a series of many years are not currently available. The specific hatchery proportions pertaining to each watershed, run, and year are presented in Appendix D (5.4). Figure 3 illustrates how natural production estimates of Chinook Salmon for different runs in each watershed are calculated.

This report uses the following references to develop Chinook Salmon production estimates: (1) a "GrandTab.2017.04.07.xls" file prepared by CDFW staff; (2) commercial and recreational salmon harvest data summarized in the Review of 2016 Ocean Salmon Fisheries [Pacific Fishery Management Council (PFMC), 2016], and (3) a "Chinookprod" database that is used by USFWS staff to calculate natural salmon production estimates [U.S. Fish and Wildlife Service (USFWS), 2012].

The data that were entered into the Chinookprod database for use in this report assume that:

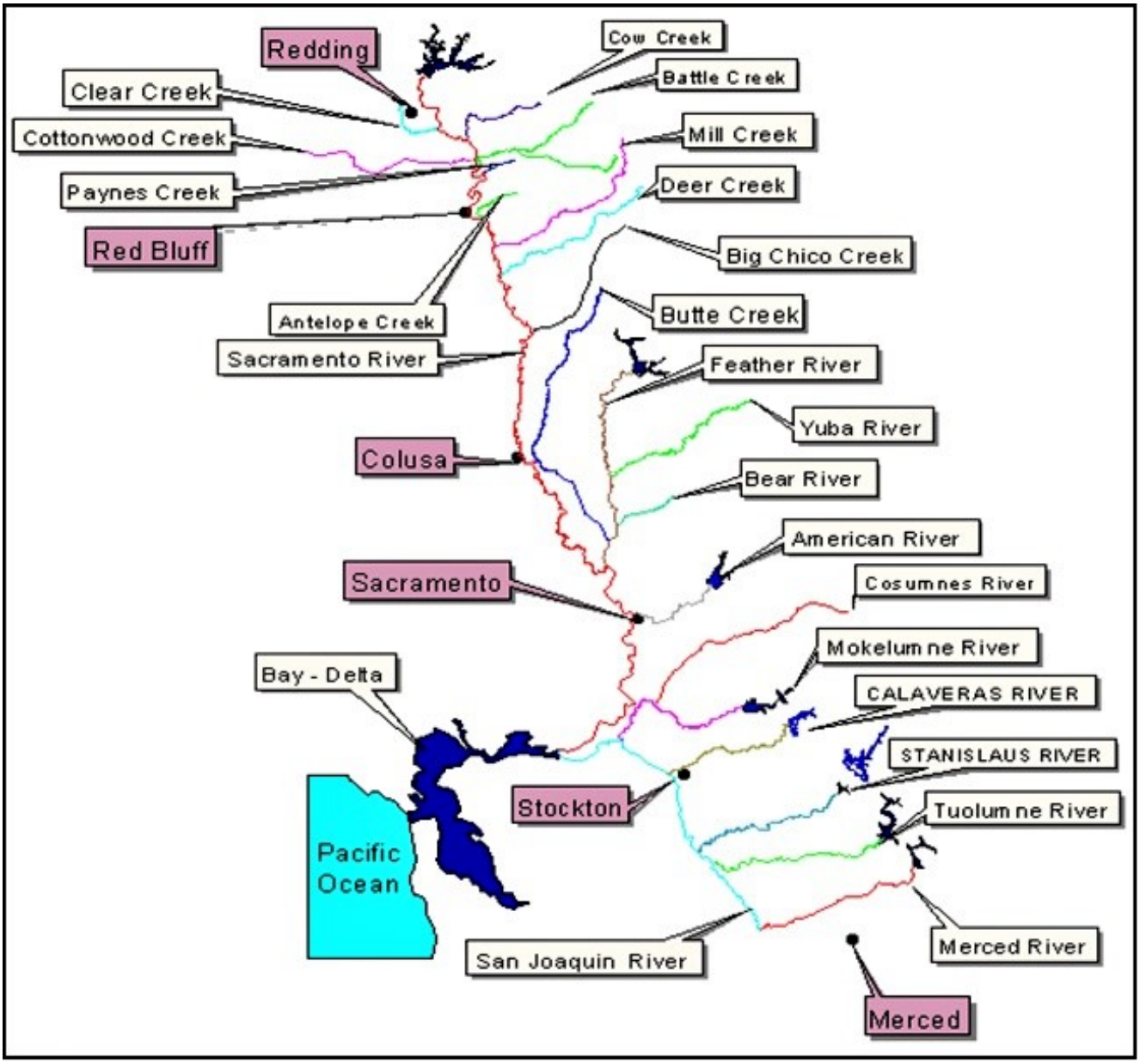
1. For the 1967-1991 baseline period, the in-river spawner and hatchery return data reflect the values in the AFRP's Working Paper on Restoration Needs document [U.S. Fish and Wildlife Service (USFWS), 1995]. Those values can sometimes deviate from the escapement data presented in the CDFW GrandTab file identified below.

2. For the 1992-2016 post-baseline period, the in-river spawner and hatchery return data from the CDFW's GrandTab.2017.04.07.xls file were imported verbatim into the Chinookprod database.

3. There was no ocean harvest of salmon in 2008 or 2009. For other years, the ocean harvest values reflect the values in the Review of 2016 Ocean Salmon Fisheries report [Pacific Fishery Management Council (PFMC), 2016].

4. For 2008 and 2009, the following in-river angler harvest proportions (AHPs) were adopted because the CDFW fishing regulations only permitted the capture and possession of Late-Fall-run Chinook

Figure 2: Watersheds and areas in the Central Valley that possess AFRP fish production targets. Figure does not include the 7 Miscellaneous Creeks described in section 3.1.1.16 of this report. The San Joaquin River does not have a fish production target and is only presented for illustrative purposes. Red labels pertain to cities and yellow labels pertain to watershed names. ↕



Salmon on the Sacramento River mainstem in those two years: (a) the Fall, Spring, and Winter-run Chinook Salmon AHPs were set to a 0 value; (b) the AHP for Late-fall-run Chinook Salmon on Battle Creek was set to a 0 value; and (c) the AHP for Late-fall-run Chinook Salmon on the Sacramento River mainstem was set to a 0.146 value. The AHPs for all four salmon runs and watersheds in years other than 2008 and 2009 were set to their normal default values, i.e., the values that existed in 2007 and presumably years prior to 2007.

2.3 Methods for Assessing Change in Adult Chinook Salmon Populations

This report uses three tools to assess the overall (cumulative) effectiveness of habitat restoration actions implemented pursuant to CVPIA Section 3406(b) in meeting the AFRP fish production targets:

1. Enumerating the number of years the estimated annual production of Chinook Salmon met or exceeded the AFRP's watershed-specific, run-specific, and Central Valley-wide production targets since 1991. In one data summary salmon returns that were at least 90% of the target were considered to have met the target to provide an optimistic accounting of uncertainty in the escapement estimates.

2. Determining the percent change in the average natural production of adult Chinook Salmon in the 22 aforementioned watersheds between the 1967-1991 and 1992-2016 time periods.

3. To evaluate potential changes in statistical properties of the indices pre- and post- 1992, four models were fit with increasing complexity, and accordingly increasing difficulty in making simple statements about differences between the two time periods. All models assumed the data were gamma distributed to ensure only positive index values are predicted with mean values modeled on the log scale. The primary difference was how the mean through time was modeled, with the following summary pertaining to the log-scale predictions,

- model 0: one linear trend describes the entire 50-year data set
- model 1: one linear trend describes 1967-1991 while a second line describes 1992-2016
- model 2: a non-linear trend describes 1967-2016 and an overall mean shift occurs beginning in 1992
- model 3: separate non-linear trends are allowed for the 1967-1991 and 1992-2016 time periods

The model fits were evaluated by comparing how much the Akaike Information Criterion (AIC) changed across models (ΔAIC). Specifically, for each salmon run or combination of runs, the model variation with the lowest AIC was set to zero (ΔAIC = 0) and other models' ΔAIC are reported as differences from the lowest model. Generally models with ΔAIC more than 2 AIC units higher than the lowest AIC model are considered less supported and models differing from a best model by more than 7 AIC units are considered much less supported. See Appendix A (5.1) for further details about the analytical method.

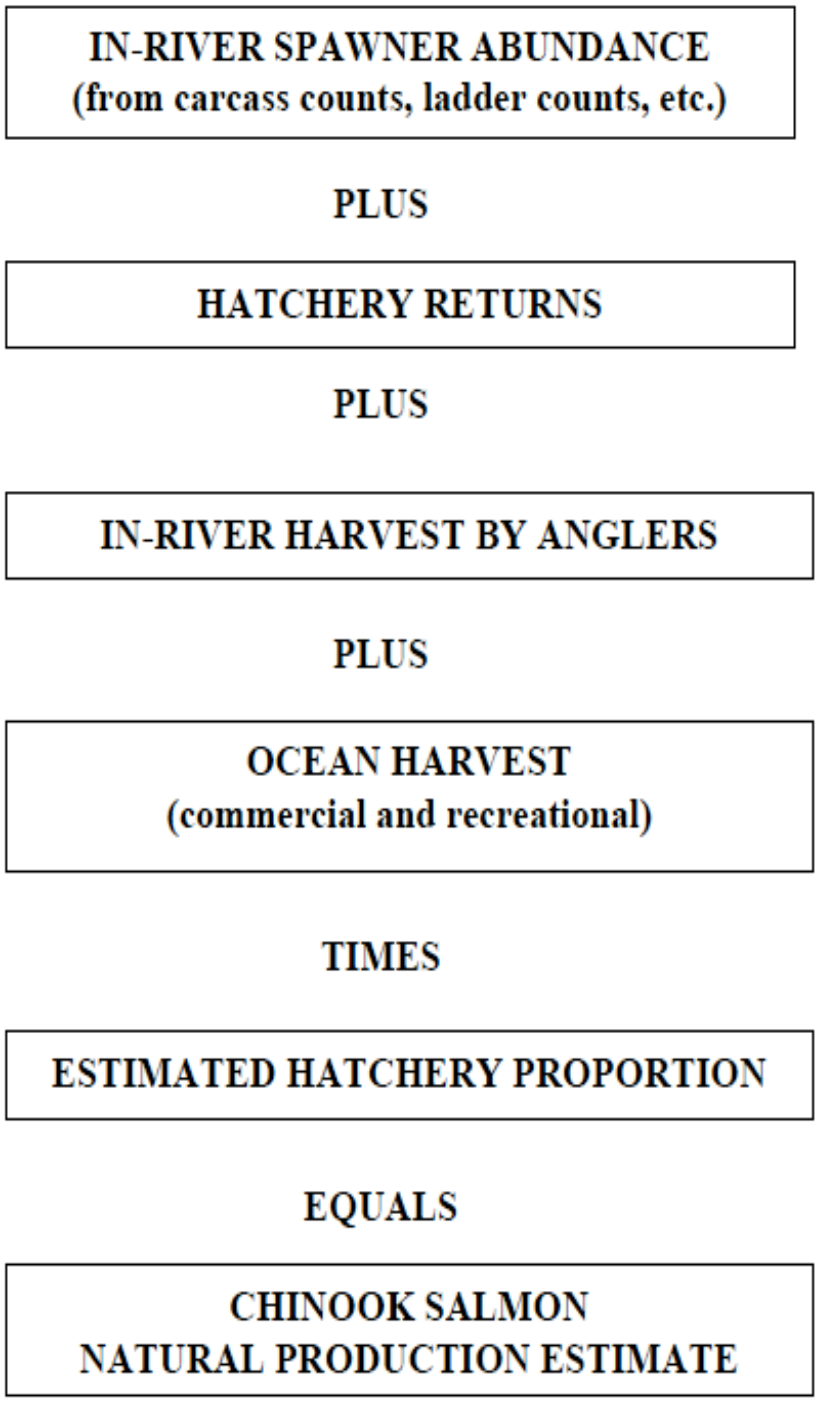
2.4 Methods for Estimating Production of Non-Salmonid Taxa

2.4.1 Methods for Adult White and Green Sturgeon

The AFRP production target for White Sturgeon pertains to the number of 15-year-old White Sturgeon in San Pablo and Suisun bays. The process that was used to develop the AFRP's white and Green Sturgeon production targets is as follows.

Production of White Sturgeon in San Pablo and Suisun bays is estimated using mark-recapture data collected by the CDFW. Prior to 2005, the CDFW normally collected mark-recapture data for White

Figure 3: Components used to calculate natural production of each run of adult Chinook Salmon in 22 Central Valley watersheds.



Sturgeon in two consecutive years, followed by a two year period when mark-recapture data were not collected. Since 2005, the CDFW has conducted White Sturgeon surveys every year to develop more robust population estimates during the post-2005 period.

Trammel nets are used to collect the mark-recapture data between August and November. Captured sturgeon are marked with tags that have unique numbers, their length is measured, and they are then released. Subsequent efforts collect marked and unmarked sturgeon and provide data to develop population estimates. A Bailey's modified Peterson model is used to estimate abundance of White Sturgeon $\geq$ 40 inches in total length, irrespective of age. A length-age key provides an estimate of the proportion of the population that is 15-years-old. The estimate of the number of 15-year-old White Sturgeon in San Pablo and Suisun bays in a given year is calculated by multiplying annual production estimates of White Sturgeon $\geq$ 40 inches in total length by the corresponding estimated fraction of the population that is 15-years-old.

Trammel net surveys in San Pablo and Suisun bays can also be used to monitor the abundance of Green Sturgeon. As surveys for White Sturgeon are conducted, the numbers of Green Sturgeon that are incidentally caught is also tabulated. Production of Green Sturgeon in a given year is calculated by dividing the annual production estimate of White Sturgeon $\geq$ 40 inches in total length by the ratio of White Sturgeon to Green Sturgeon caught that year, i.e., abundance of Green Sturgeon $\geq$ 40 inches in length = abundance of White Sturgeon $\geq$ 40 inches in length * (number of captured Green Sturgeon $\geq$ 40 inches in length / number of captured White Sturgeon $\geq$ 40 inches in length). The estimate of Green Sturgeon production is therefore indexed to the total production of White Sturgeon $\geq$ 40 inches in total length, and is not related to the estimated number of 15-year-old White Sturgeon.

This report uses the following CDFW spreadsheets to develop White Sturgeon production estimates: (1) a "CUMPOP_MD2a.xls" file dated March 13, 2007; (2) a "WSTALKEY.xls" file dated December 22, 2006; and (3) a "Stu Data for Doug Threloff 121611.xls" file dated December 16, 2011. The CDFW spreadsheets that provided length-frequency information used to develop population estimates for Green Sturgeon include: (1) a "WST_length_1990-2006.xls" file dated June 6, 2007; (2) a "Qry_Length_GST_ALL.xls" file dated June 1, 2007; and (3) a "Stu Data for Doug Threloff 121611.xls" file dated December 16, 2011.

2.4.2 Methods for Juvenile American Shad

Unlike the other seven fish taxa described in this report, changes in the abundance of American Shad are indexed to a juvenile, i.e., young-of-the-year (YOY), age class instead of an adult age class. The Fall Midwater Trawl (FMWT) survey provides data to estimate the juvenile abundance index for American Shad.

FMWT sampling has occurred nearly every year since 1967, but CDFW did not conduct surveys in 1974 and 1979; in 1976, surveys only occurred in October and November, but CDFW staff have estimated a full four-month index would have been for that year.

The FMWT survey is conducted in the Sacramento-San Joaquin River Delta, San Pablo Bay, and Suisun Bay. Within this region, the FMWT surveys are conducted in 17 different areas. Within these 17 areas, a series of 100 "core index stations" exist. The core index stations used to estimate the juvenile American Shad abundance index in this report are 303, 305-316, 321-340, 401-418, 501-519, 601-608, 701-711, 802, 804, 806-815, and 901-915.

For each month when the FMWT survey is conducted, catches of American Shad within each area are summed and an average catch per tow is calculated. The average catch per tow for each area is then weighted by the water volume (thousands of acre feet) in that area. The weighted catches are summed over all areas. This sum is the monthly survey index and it includes American Shad of all ages (YOY, 1-, 2-, and 3-year old fish), although the vast majority of the captured Shad are in the YOY age class. The indices from the four monthly surveys are summed to develop an annual index.

As American Shad are collected during the FMWT survey, the lengths of the first 50 shad caught at each index station are measured. The length frequency of the measured shad is then expanded to the total

catch to develop adjusted length frequencies. These data are then used to determine the proportion of shad less than 1-year old, i.e., fish that are in the YOY age class.

Because the AFRP production target for American Shad is limited to the YOY abundance index, the CAMP has prorated the CDFW's all-ages abundance index by the proportion of fish in the YOY age class. Text in Appendix E (5.5) provides additional information on the procedure to transform the annual all-ages abundance index to an index limited to the YOY age class. Since 2009 the CAMP has used a length frequency correction factor to calculate the number of shad in the YOY age class after 1992 because this factor adjusts for instances when every shad in a trawl was not measured for length; this length frequency correction factor is likely to lead to more accurate estimations of the number of YOY American Shad caught each year [White, 2020]. The raw data used to develop American Shad production estimates in this report are contained in two references that were provided by James White [White, 2020] of the CDFW on January 31, 2020: (1) a "FMWT AMS Indices 1967-2019.xls" spreadsheet; and (2) an "FMWT AMS Length Frequency 1971-2019.xls" spreadsheet.

2.4.3 Methods for Adult Striped Bass

The CDFW monitors abundance of "legal-size" Striped Bass in anadromous waters in the Central Valley. "Legal-size" refers to the minimum length of Striped Bass that anglers can legally harvest, per the fishing regulations determined by the F & W Commission. The length of legal-size fish has changed over time. Prior to 1982, legal-size Striped Bass were considered to be 16 or more inches in length. From 1982 to the present time, legal-size Striped Bass have been considered to be 18 or more inches in length.

A mark-recapture technique is used to monitor abundance of legal-size Striped Bass. The CDFW uses gill nets and/or fyke traps to collect Striped Bass from early April to as late as mid-June. These collections usually occur each year. Nets and traps collect Striped Bass between Broad Slough and Colusa on the Sacramento River and between Broad Slough and Venice Island on the San Joaquin River. As Striped Bass are collected they are measured, tagged with individually numbered disc-dangler tags, and released. The CDFW conducts creel surveys on a year-round basis each year to monitor the number and proportion of marked and unmarked Striped Bass. These creel censuses occur between the Pacific Ocean and Colusa on the Sacramento River, and between the Pacific Ocean and Mossdale on the San Joaquin River. A Bailey's modified Peterson model is used to estimate production of adult Striped Bass based on the mark-recapture data [Stevens et al., 1985].

The pre-2010 Striped Bass abundance estimates provided in this report are based on the above-mentioned mark-recapture data and the Bailey's modified Peterson model. The 2010, 2011, and 2012 Striped Bass abundance estimates in this report are predicted values based on a linear regression equation that reflects catch per unit effort (CPUE) and Striped Bass abundance estimates developed with the mark-recapture data. The CPUE data has been collected from commercial passenger fishing vessels (i.e., "party boats") since 1980 and through the present day.

3 RESULTS

3.1 Production Estimates for Chinook Salmon

Because adult Chinook Salmon data collected in 2016 are subject to revision and refinement, salmon production estimates and any analyses for this year should be considered provisional. Annual production estimates for individual watersheds, runs, and the Central Valley are tabulated in Appendix D (5.4). The presence of a fish hatchery in a watershed confounds the ability to monitor natural production of Chinook Salmon because it is not always possible to accurately discriminate between, and therefore count, wild salmon and unmarked hatchery salmon.

3.1.1 Production Estimates for Individual Watersheds

The details of how each stream with at least one AFRP target have performed are provided in section 3.1.1.1 through section 3.1.2.4. The ability of streams to meet the AFRP targets has varied widely ranging from 0% to 88% of years since 1992 (Figure 15). Butte Creek, Clear Creek, and Battle Creek have been the three best-performing streams in terms of meeting AFRP target salmon abundances. The Stanislaus River, the Sacramento River (mainstem) and several Sacramento River tributaries have not met their AFRP targets since before 1992; in extreme cases, not since the 1970s.

3.1.1.1 American River

Estimates of natural production of adult Fall-run Chinook Salmon from the American River between 1992 and 2016 are presented in Table 2 and Figure 4. The AFRP production target for Fall-run Chinook Salmon from the American River is 160,000 salmon. Estimated natural production of this run of Chinook Salmon from this watershed exceeded the AFRP production target six times of 25 between 1992 and 2016.

3.1.1.2 Antelope Creek

Estimates of natural production of adult Fall-run Chinook Salmon from Antelope Creek between 1992 and 2016 are presented in Table 2. The AFRP production target for Fall-run Chinook Salmon from Antelope Creek is 720 salmon. Monitoring data that can be used to estimate the production of Fall-run Chinook Salmon from Antelope Creek have only been collected in four years between 1992 and 2016. In the years 1992, 2014, 2015, and 2016, 0, 177, 8, and 169 adult Fall-run Chinook Salmon were produced by Antelope Creek, respectively, and the AFRP production target of 720 salmon therefore was not met.

3.1.1.3 Battle Creek

Estimates of natural production of adult Fall-run Chinook Salmon from Battle Creek between 1992 and 2016 are presented in Table 2 and Figure 4. The AFRP production target for Fall-run Chinook Salmon from Battle Creek is 10,000 salmon. Estimated natural production of this run of Chinook Salmon from this watershed exceeded the AFRP production target 15 times between 1992 and 2016.The last year that the AFRP production was met was in 2013.

Estimates of natural production of adult Late-fall-run Chinook Salmon from Battle Creek during the period 1992-2016 are presented in Table 2 and Figure 9. The AFRP production target for adult Late-fall-run Chinook Salmon from Battle Creek is 550 salmon. Estimated natural production of this run of Chinook Salmon from this watershed may have exceeded the AFRP production target 17 times between 1992 and 2016.

The inference of the number of times the AFRP production target for Late-fall-run Chinook Salmon from Battle Creek is confounded by multiple factors. First, the Chinookprod spreadsheet used to develop production estimates relies solely on counts of adult (and predominantly hatchery-origin) salmon returning to the hatchery and in-river escapement estimates of wild salmon are not available. There are, therefore, no definitive monitoring data to infer what the natural production of adult Late-fall-run Chinook Salmon from Battle Creek has been. Second, a relatively small number (i.e., 19-216) of wild late-fall-run salmon entered Coleman National Fish Hatchery between 2000 and 2016 and were released upstream of the hatchery, thereby contributing to natural in-river escapement. These fish have been accounted for in the Chinookprod and GrandTab spreadsheets and are used to calculate and track natural production. Third, because the management practices for hatchery-origin late-fall-run Chinook Salmon have improved since 1996, the number of hatchery-produced Late-fall-run Chinook Salmon has increased since that time. ↕

Table 2: Estimated natural production of adult Fall, Late-fall, Winter, and Spring run Chinook Salmon from 22 watersheds in the Central Valley, 1992-2016. Cells with a - (dash) represent years when data were not collected for a particular run and location.

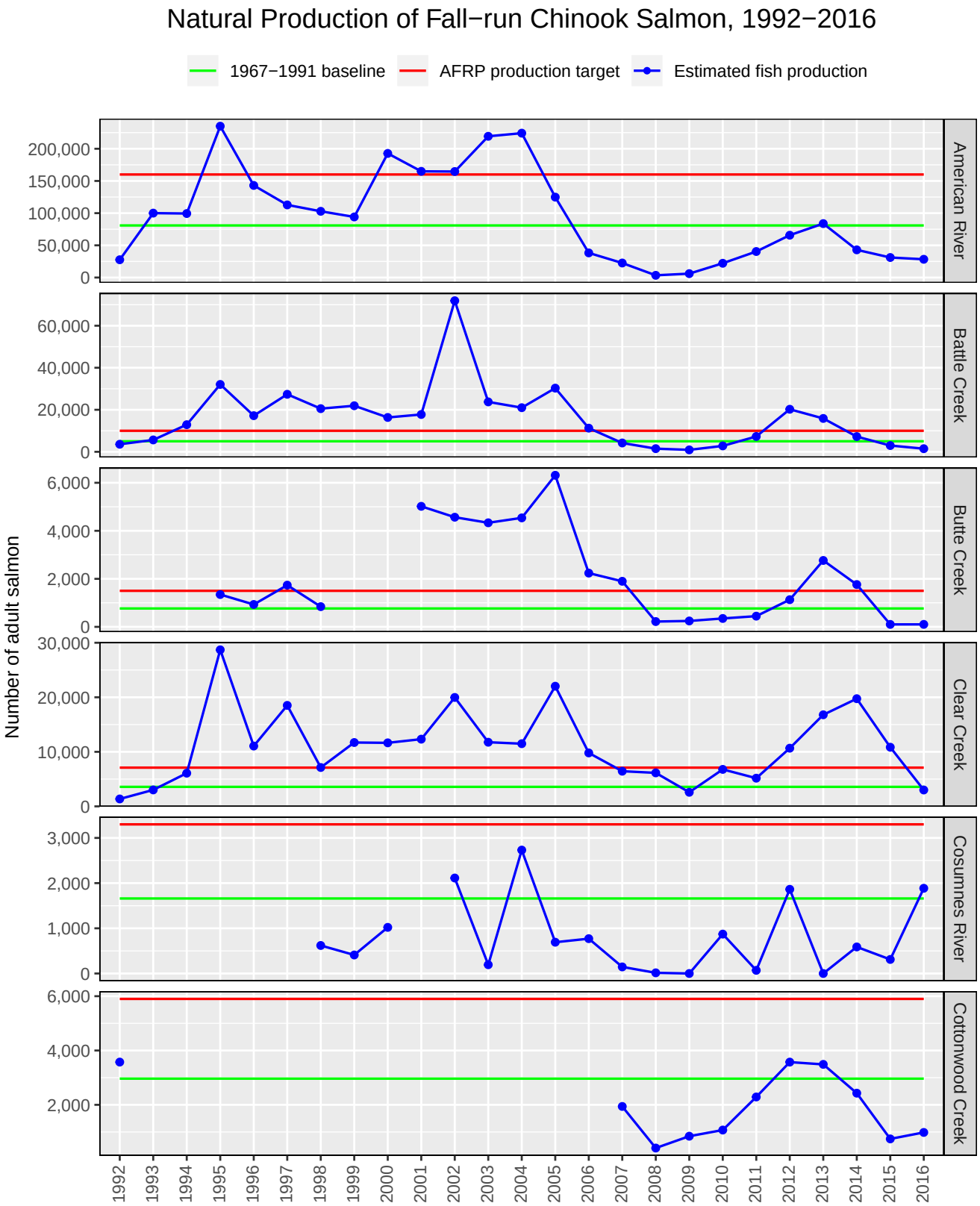
Fall Run Chinook Salmon	1967–1991 baseline	AFRP Production target	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
American River	80,874	160,000	27,618	100,028	99,415	235,027	143,005	112,797	102,859	94,113	192,719	164,912	164,608	219,322	224,190	124,868	38,276	22,566	3,448	6,052	22,166	40,418	65,744	83,796	43,020	31,115	28,351
Antelope Creek	361	720	0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	177	8	169
Battle Creek	5,013	10,000	3,588	5,648	12,897	32,060	17,191	27,365	20,539	21,916	16,341	17,756	71,890	23,750	20,993	30,302	11,250	4,197	1,492	920	2,813	7,285	20,239	15,876	7,240	2,980	1,477
Bear River	639	450	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Big Chico Creek	402	800	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Butte Creek	765	1,500	–	–	–	1,346	931	1,736	841	–	–	5,019	4,565	4,333	4,538	6,312	2,238	1,897	220	245	349	445	1,131	2,764	1,761	101	102
Clear Creek	3,576	7,100	1,358	3,017	6,085	28,704	11,062	18,515	7,127	11,707	11,648	12,322	19,972	11,761	11,492	22,030	9,799	6,445	6,142	2,582	6,779	5,166	10,667	16,794	19,742	10,847	3,004
Cosumnes River	1,660	3,300	–	–	–	–	–	–	620	410	1,021	–	2,113	194	2,731	692	771	146	15	0	872	70	1,863	0	588	311	1,886
Cottonwood Creek	2,964	5,900	3,574	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,940	408	844	1,071	2,289	3,573	3,489	2,429	745	983
Cow Creek	2,330	4,600	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4,898	3,171	382	209	505	1,930	2,085	3,790	4,422	728	995
Deer Creek	766	1,500	–	176	737	–	–	2,580	449	–	–	–	–	–	544	1,418	2,216	874	155	46	156	707	1,222	1,289	1,062	752	304
Feather River	86,028	170,000	74,927	85,238	104,572	181,758	99,824	115,982	25,828	15,468	189,180	188,783	127,696	106,619	111,437	86,975	86,129	35,634	6,512	8,886	50,048	69,777	120,988	184,249	86,535	39,356	58,230
Merced River	9,005	18,000	2,396	4,381	9,212	9,652	8,902	8,470	7,335	7,470	24,450	13,196	14,263	4,113	8,365	3,773	1,970	943	418	544	807	2,225	4,526	5,301	2,324	3,245	7,192
Mill Creek	2,118	4,200	2,262	4,787	2,568	–	–	1,018	903	–	–	–	3,236	3,014	2,171	3,618	1,633	1,323	174	82	136	1,314	1,237	2,761	3,114	1,272	730
Miscellaneous Creeks	549	1,100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	214	15	5	–	–	–	–	–	2	38
Mokelumne River	4,680	9,300	2,781	5,747	5,641	12,769	11,116	16,494	9,037	5,840	9,702	6,836	10,012	9,539	16,178	17,792	5,122	1,771	247	1,340	5,087	14,885	12,673	11,576	11,356	11,898	8,049
Paynes Creek	170	330	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	228	94	0	12
Sacramento River	115,369	230,000	54,599	84,175	104,713	147,850	117,862	193,147	7,924	176,797	126,217	64,020	61,196	83,102	59,042	63,513	48,416	19,846	14,846	3,496	11,575	9,570	30,087	37,862	32,690	26,472	4,149
Stanislaus River	10,868	22,000	695	1,946	2,924	2,241	365	14,424	6,145	7,577	17,671	9,503	11,527	8,753	8,623	2,532	2,671	824	865	595	1,222	1,669	6,688	4,275	4,559	9,015	13,471
Tuolumne River	18,949	38,000	362	1,377	1,430	3,056	9,723	18,437	17,777	14,348	37,121	11,886	10,631	3,192	4,287	1,201	778	410	388	124	607	1,140	1,295	2,896	650	169	1,945
Yuba River	33,267	66,000	17,957	20,326	32,458	54,836	65,180	70,035	64,954	44,305	32,618	33,158	37,345	43,954	34,427	32,728	11,818	5,052	3,508	4,635	16,939	11,913	13,397	23,426	18,150	10,018	6,139
Total	380,355	754,800	192,117	316,846	382,650	709,299	485,160	601,000	272,337	399,951	658,688	527,391	539,052	521,646	509,017	397,755	227,985	107,253	39,236	30,604	121,132	170,804	297,415	400,371	239,911	149,033	137,227

Late−Fall Run Chinook Salmon	1967–1991 baseline	AFRP Production target	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Battle Creek	273	550	106	174	195	134	340	1,350	702	1,410	991	392	746	548	1,281	1,131	773	726	635	647	711	679	585	628	850	1,163	397
Sacramento River	33,941	68,000	27,672	2,237	869	630	112	–	82,325	15,889	18,942	27,363	55,991	8,596	20,063	19,707	14,826	29,782	4,170	3,568	5,149	4,978	5,025	8,310	12,499	3,414	4,770
Total	34,214	68,550	27,778	2,411	1,063	764	453	1,350	83,027	17,299	19,933	27,756	56,737	9,144	21,343	20,838	15,600	30,508	4,806	4,215	5,860	5,657	5,610	8,938	13,349	4,577	5,167

Spring Run Chinook Salmon	1967–1991 baseline	AFRP Production target	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Butte Creek	1,018	2,000	2,061	1,968	1,412	28,877	3,311	1,702	42,323	6,716	8,968	13,604	13,630	6,831	16,664	19,742	6,663	9,582	3,935	2,059	1,367	2,843	15,044	18,057	5,652	2,540	15,402
Deer Creek	3,276	6,500	590	784	1,444	4,987	1,439	1,249	3,925	2,904	1,387	2,297	3,406	4,285	1,813	4,160	3,539	1,248	140	213	309	362	1,282	1,114	1,298	412	501
Mill Creek	2,202	4,400	669	185	2,154	1,232	593	541	885	1,022	1,185	1,564	2,473	2,215	2,250	2,137	1,458	1,783	381	220	568	489	1,341	1,014	1,061	195	265
Sacramento River	29,412	59,000	1,143	1,291	2,801	1,789	966	374	2,542	522	102	960	330	0	911	60	0	524	52	0	0	0	0	0	0	0	0
Total	35,907	71,900	4,463	4,229	7,811	36,884	6,309	3,866	49,676	11,163	11,643	18,424	19,839	13,331	21,638	26,099	11,659	13,138	4,508	2,492	2,244	3,694	17,668	20,185	8,011	3,148	16,168

Winter Run Chinook Salmon	1967–1991 baseline	AFRP Production target	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Calaveras River	770	2,200	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0	0	0	0	0	–	–	–	–	–
Sacramento River	54,316	110,000	3,167	1,060	505	4,284	2,160	2,079	5,680	5,472	2,657	9,938	9,195	10,911	14,862	21,511	19,712	4,142	2,555	4,070	1,534	899	3,801	7,814	3,837	4,321	1,905
Total	55,086	112,200	3,167	1,060	505	4,284	2,160	2,079	5,680	5,472	2,657	9,938	9,195	10,911	14,862	21,511	19,712	4,142	2,555	4,070	1,534	899	3,801	7,814	3,837	4,321	1,905

Figure 4: Estimated natural production of adult Fall run Chinook Salmon from American River, Battle Creek, Butte Creek, Clear Creek, Cosumnes River, and Cottonwood Creek 1992-2016. Each graph provides the watershed's AFRP production target, estimated annual natural production of Chinook Salmon between 1992 and 2016, and average natural production of Chinook Salmon between 1967 and 1991.



3.1.1.4 Bear River

Monitoring data that can be used to estimate the production of Fall-run Chinook Salmon from Bear River have not been collected in any year between 1992 and 2016. It is therefore not possible to determine if the AFRP production target of 450 salmon was met in this watershed during that period.

3.1.1.5 Big Chico Creek

Monitoring data that can be used to estimate the production of Fall-run Chinook Salmon from Big Chico Creek have not been collected in any year between 1992 and 2016. It is therefore not possible to determine if the AFRP production target of 800 salmon was met in this watershed during that period.

3.1.1.6 Butte Creek

Estimates of natural production of adult Fall-run Chinook Salmon from Butte Creek between 1992 and 2016 are presented in Table 2 and Figure 4. Estimates of natural production are not available for 1992, 1993, 1994, 1999, and 2000. The AFRP production target for Fall-run Chinook Salmon from Butte Creek is 1,500 salmon. Estimated natural production of this run of Chinook Salmon from this watershed exceeded the AFRP production target 10 times in the 20 years when monitoring data were collected between 1992 and 2016.

Estimates of natural production of adult Spring-run Chinook Salmon from Butte Creek between 1992 and 2016 are presented in Table 2 and Figure 7. The AFRP production target for Spring-run Chinook Salmon from Butte Creek is 2,000 salmon. Estimated natural production of this run of Chinook Salmon from that watershed exceeded the AFRP production target 21 times between 1992 and 2016.

3.1.1.7 Calaveras River

Estimates of natural production of adult Winter-run Chinook Salmon from Calaveras River between 1992 and 2016 are presented in Table 2. The AFRP production target for Winter-run Chinook Salmon from the Calaveras River is 2,200 salmon. Since 1992, surveys for Winter-run Chinook Salmon from the Calaveras River were conducted in 2007, 2008, 2009, 2010, and 2011. In each of those years, no Winter-run Chinook Salmon were detected, i.e., the AFRP production target for Winter-run Chinook Salmon from the Calaveras River was not met in any of the five years when surveys were done since 1992. The absence of Winter-run Chinook Salmon in the Calaveras River during recent surveys may not be unusual, given that Yoshiyama et al. (2001) [Yoshiyama, R.M., E.R. Gerstung, F.W. Fisher and P.B. Moyle, 2001] suggested Winter-run Chinook Salmon may not have existed in the Calaveras River. The putative Winter-run fish observed from 1972-1984 may actually have been a late-fall-run attracted to the river when flows were released in late winter and spring by New Hogan Dam.

3.1.1.8 Clear Creek

Estimates of natural production of adult Fall-run Chinook Salmon from Clear Creek between 1992 and 2016 are presented in Table 2 and Figure 4. The AFRP production target for Fall-run Chinook Salmon from Clear Creek is 7,100 salmon. Estimated natural production of this run of Chinook Salmon from that watershed exceeded the AFRP production target 16 times between 1992 and 2016.

3.1.1.9 Cosumnes River

Estimates of natural production of adult Fall-run Chinook Salmon from Cosumnes River between 1992 and 2016 are presented in Table 2 and Figure 4. The AFRP production target for Fall-run Chinook Salmon from the Cosumnes River is 3,300 salmon. Monitoring data for Chinook Salmon from the Cosumnes River were collected in 18 years of the 25 years since 1991. The production target was not met in any of those 18 years when Chinook Salmon surveys were conducted on the Cosumnes River since 1991.

3.1.1.10 Cottonwood Creek

Estimates of natural production of adult Fall-run Chinook Salmon from Cottonwood Creek between 1992 and 2016 are presented Table 2 and Figure 4. The AFRP production target for Fall-run Chinook Salmon from Cottonwood Creek is 5,900 salmon. Monitoring data for Chinook Salmon from Cotton-

wood Creek have only been collected 11 times since 1991. The production target was not met in any of the 11 years when monitoring data were collected since 1991.

3.1.1.11 Cow Creek

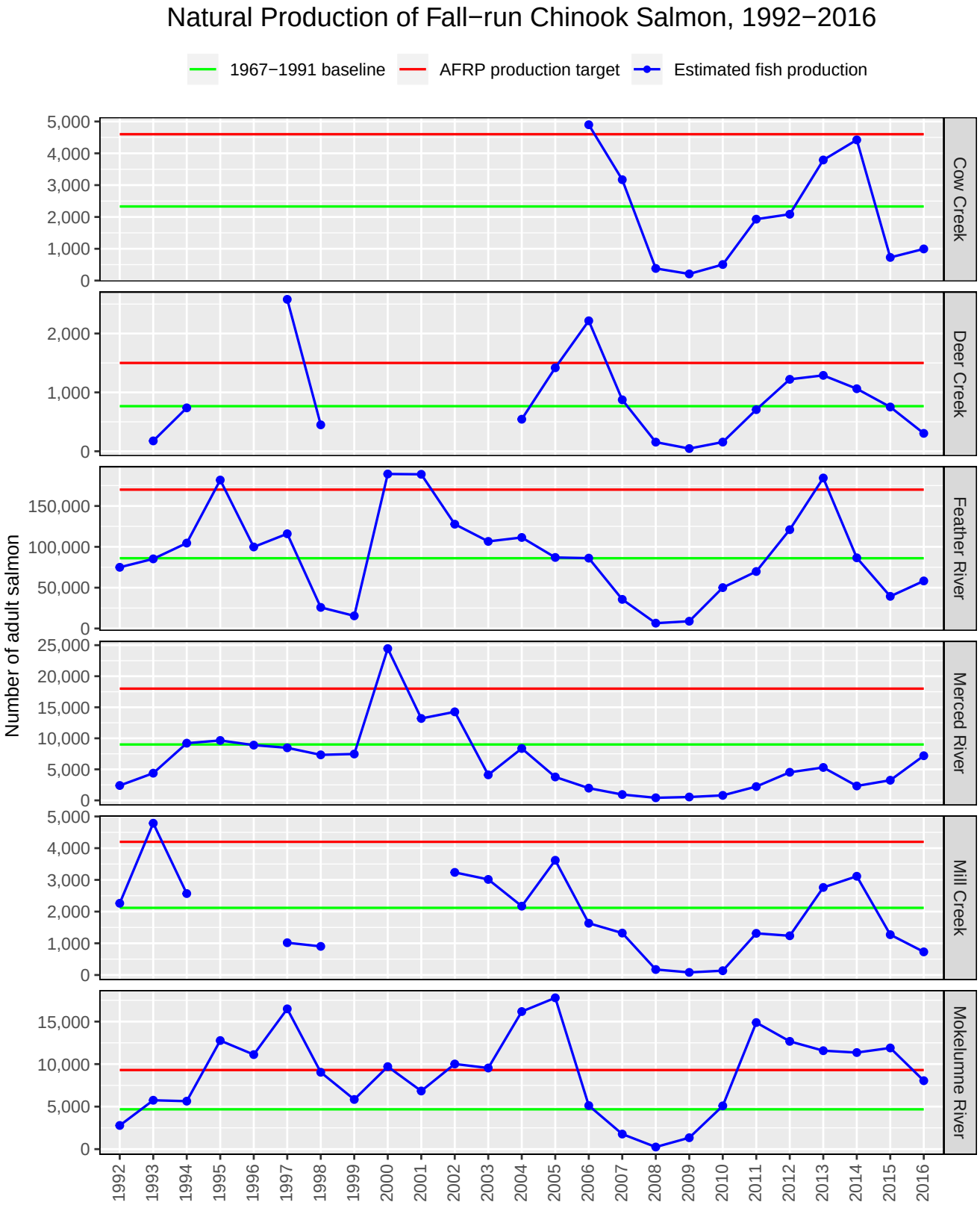
Estimates of natural production of adult Fall-run Chinook Salmon from Cow Creek between 1992 and 2016 are presented in Table Table 2 and Figure 5. The AFRP production target for Fall-run Chinook Salmon from Cow Creek is 4,600 salmon. Monitoring data for Chinook Salmon from Cow Creek have only been collected 11 times since 1991. The AFRP production target was met in one of the 11 years when monitoring data were collected since 1991.

3.1.1.12 Deer Creek

Estimates of natural production of adult Fall-run Chinook Salmon from Deer Creek between 1992 and 2016 are presented in Table 2 and Figure 5. The AFRP production target for Fall-run Chinook Salmon from Deer Creek is 1,500 salmon. Production estimates are not available for 1992, 1995, 1996, 1999, 2000, 2001, 2002, and 2003. Estimated natural production exceeded the AFRP production target twice in the 17 years when monitoring data were collected between 1992 and 2016.

Estimates of natural production of adult Spring-run Chinook Salmon from Deer Creek between 1992 and 2016 are presented in Table 2 and Figure 7. The AFRP production target for adult Spring-run Chinook Salmon from Deer Creek is 6,500 salmon. Estimated natural production of adult Spring-run Chinook Salmon from this watershed never equaled or exceeded the AFRP production target between 1992 and 2016.

Figure 5: Estimated natural production of adult Fall run Chinook Salmon from Cow Creek, Deer Creek, Feather River, Merced River, Mill Creek, and Mokelumne River 1992-2016. Each graph provides the watershed's AFRP production target, estimated annual natural production of Chinook Salmon between 1992 and 2016, and average natural production of Chinook Salmon between 1967 and 1991. ↕



3.1.1.13 Feather River

Estimates of natural production of adult Fall-run Chinook Salmon from the Feather River between 1992 and 2016 are presented in Table 2 and Figure 5. Prior to 2005, estimates of the number of Fall-run Chinook Salmon that returned to the hatchery included a combination of Fall and Spring-run Chinook Salmon because no simple method for distinguishing between the two runs existed. Beginning in 2005 and to the present time, Spring-run Chinook Salmon have been marked with floy tags and released back into the river so they can be distinguished from Fall-run Chinook Salmon as Fall-run salmon return to the hatchery. However, hatchery return numbers used to estimate natural production of Fall-run Chinook Salmon continue to include some Spring-run Chinook Salmon; this tends to inflate the Fall-run production estimates to some degree. Natural production estimates for 1998 and 1999 are anomalously low because carcass surveys were not used to estimate in-river spawner abundance. The AFRP production target for Fall-run Chinook Salmon from the Feather River is 170,000 salmon. Estimated natural production of adult Fall-run Chinook Salmon from this watershed equaled or exceeded this AFRP production target four times between 1992 and 2016, i.e., in 1995, 2000, 2001, and 2013.

3.1.1.14 Merced River

Estimates of natural production of adult Fall-run Chinook Salmon from the Merced River between 1992 and 2016 are presented in Table 2 and Figure 5. The AFRP production target for adult Fall-run Chinook Salmon from the Merced River is 18,000 salmon. Estimated natural production equaled or exceeded the AFRP production target once between 1992 and 2016.

3.1.1.15 Mill Creek

Estimates of natural production of adult Fall-run Chinook Salmon from Mill Creek between 1992 and 2016 are presented in Table 2 and Figure 5. The AFRP production target for Fall-run Chinook Salmon from Mill Creek is 4,200 salmon. Monitoring data for Fall-run Chinook Salmon from Mill Creek were not collected in 1995, 1996, 1999, 2000, and 2001. Estimated natural production exceeded the AFRP production target once in the 20 years when monitoring data were collected since 1991.

Estimates of natural production of adult Spring-run Chinook Salmon from Mill Creek between 1992 and 2016 are presented in Table 2 and Figure 7. The AFRP production target for Spring-run Chinook Salmon from Mill Creek is 4,400 salmon. The estimated natural production of these fish from that watershed never equaled or exceeded the AFRP production target between 1992 and 2016.

3.1.1.16 Miscellaneous Creeks

The AFRP fish production target for the Miscellaneous Creeks includes the combined production from seven watersheds above the site of the former Red Bluff Diversion Dam. These watersheds are Spring Gulch, China Gulch, Olney Creek, Ash Creek, Stillwater Creek, Inks Creek, and Bear Creek (Rick Burmester, AFRP-retired, pers. comm.). The combined production target for these watersheds only pertains to Fall-run Chinook Salmon. Between 1992 and 2006, the abundance of Chinook Salmon was not monitored in any of the seven Miscellaneous Creeks. In 2007, 2008, 2009, 2015, and 2016 the only Creek where monitoring for Chinook Salmon took place was Bear Creek. Estimates of the natural production of adult Fall-run Chinook Salmon from Bear Creek, are presented in Table 2. The AFRP production target for Fall-run Chinook Salmon from the seven Miscellaneous Creeks is 1,100 salmon. The natural production of Fall-run Chinook Salmon from Bear Creek did not exceed the AFRP Miscellaneous Creek production target in any of the 5 years when monitoring data were collected.

3.1.1.17 Mokelumne River

Estimates of natural production of adult Fall-run Chinook Salmon from the Mokelumne River between 1992 and 2016 are presented in Table 2 and Figure 5. The AFRP production target for Fall-run Chinook Salmon on the Mokelumne River is 9,300 salmon. Estimated natural production equaled or exceeded this AFRP production target 13 times between 1992 and 2016.

3.1.1.18 Paynes Creek

Monitoring data that can be used to estimate the production of Fall-run Chinook Salmon from Paynes Creek was only collected in three years between 1992 and 2016. Those years occurred in 2013, 2014, 2015, and 2016 when the production was 228, 94, 0, and 12 adult salmon, respectively. The AFRP production target of 330 salmon for Paynes Creek was therefore not met in either of the years when monitoring occurred during the post-baseline period.

3.1.1.19 Sacramento River Mainstem

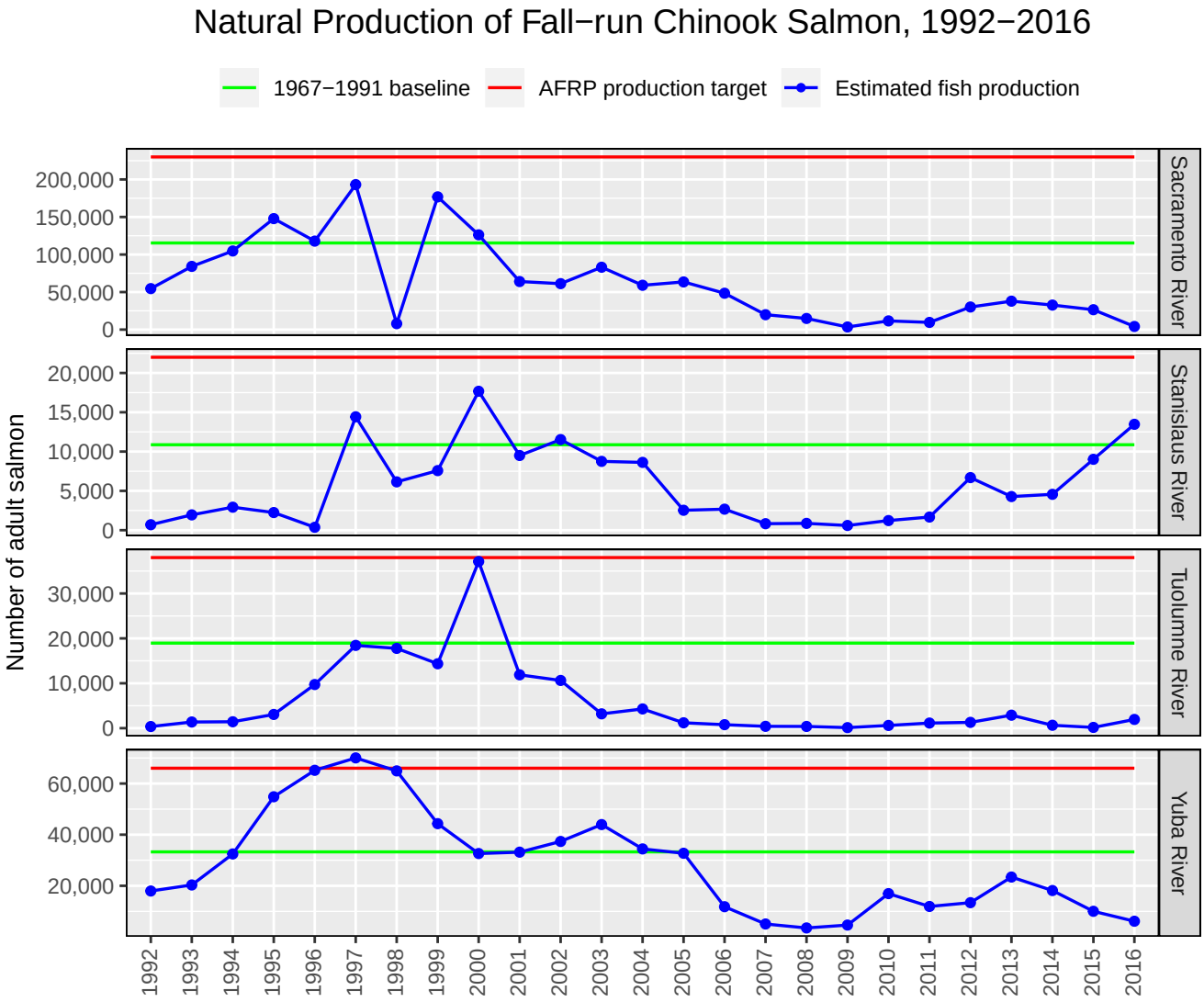
Estimates of natural production of adult Fall-run Chinook Salmon from the Sacramento River mainstem between 1992 and 2016 are presented in Table 2 and Figure 6. The AFRP production target for Fall-run Chinook Salmon from the Sacramento River is 230,000 salmon. Estimated natural production of this run of Chinook Salmon from that watershed never equaled or exceeded the AFRP production target between 1992 and 2016.

Estimates of natural production of adult Late-fall-run Chinook Salmon between 1992 and 2016 are presented in Table 2 and Figure 9. Monitoring data for this salmon run and watershed were not collected in 1997. The AFRP production target for Late-fall-run Chinook Salmon from the Sacramento River is 68,000 salmon. Estimated natural production of this run of Chinook Salmon from that watershed exceeded the AFRP production target once (1998) in the 24 years when monitoring data were collected between 1992 and 2016.

Estimates of natural production of adult Spring-run Chinook Salmon from the Sacramento River mainstem between 1992 and 2016 are presented in Table 2 and Figure 7. The AFRP production target for Spring-run Chinook Salmon from the Sacramento River is 59,000 salmon. Escapement estimates for this run in the watershed in 2003, 2006, and between 2009 and 2016 were zero because no Spring-run Chinook Salmon were observed to spawn in the Sacramento River mainstem during those years. The estimated natural production of adult Spring-run Chinook Salmon from the Sacramento River mainstem therefore never equaled or exceeded the AFRP production target between 1992 and 2016.

Estimates of natural production of adult Winter-run Chinook Salmon from the Sacramento River mainstem between 1992 and 2016 are presented in Table 2 and Figure 8. The AFRP production target for Winter-run Chinook Salmon from the Sacramento River is 110,000 salmon. Estimated natural production of this run of Chinook Salmon from that watershed never equaled or exceeded the AFRP production target between 1992 and 2016.

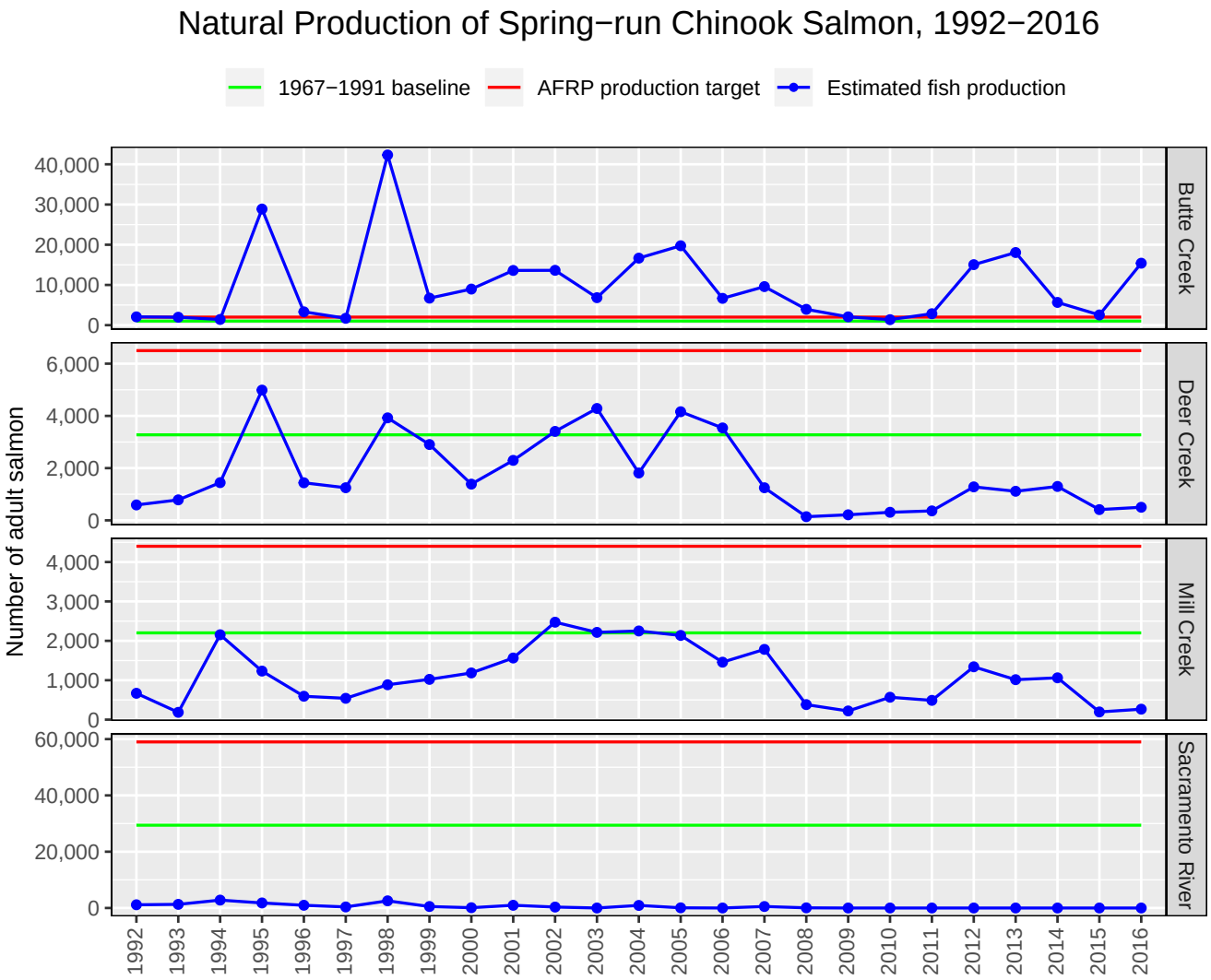
Figure 6: Estimated natural production of adult Fall run Chinook Salmon from the Sacramento River, Stanislaus River, Tuolumne River, and Yuba River, 1992-2016. Each graph provides the watershed's AFRP production target, estimated annual natural production of Chinook Salmon between 1992 and 2016, and average natural production of Chinook Salmon between 1967 and 1991.



3.1.1.20 Stanislaus River

Estimates of natural production of adult Fall-run Chinook Salmon from the Stanislaus River between 1992 and 2016 are presented in Table 2 and Figure 6. The AFRP production target for Fall-run Chinook Salmon from the Stanislaus River is 22,000 salmon. The estimated natural production of adult Fall-run Chinook Salmon from this watershed never equaled or exceeded the AFRP production target between 1992 and 2016.

Figure 7: Estimated natural production of adult Spring Chinook Salmon from Butte Creek, Deer Creek, Mill Creek, and the Sacramento River Mainstem 1992-2016. Each graph provides the watershed's AFRP production target, estimated annual natural production of Chinook Salmon between 1992 and 2016, and average natural production of Chinook Salmon between 1967 and 1991.



3.1.1.21 Tuolumne River

Estimates of natural production of adult Fall-run Chinook Salmon from the Tuolumne River between 1992 and 2016 are presented in Table 2 and Figure 6. The AFRP production target of Fall-run Chinook Salmon from the Tuolumne River is 38,000 salmon. Estimated natural production of adult Fall-run Chinook Salmon from this watershed never equaled or exceeded the AFRP production target between 1992 and 2016.

3.1.1.22 Yuba River

Estimates of natural production of adult Fall-run Chinook Salmon from the Yuba River between 1992 and 2016 are presented in Table 2 and Figure 6. The AFRP production target of Fall-run Chinook Salmon from the Yuba River is 66,000 salmon. Estimated natural production of adult Fall-run Chinook Salmon from this watershed equaled or exceeded the AFRP production target one year between 1992 and 2016, i.e., in 1997.

Figure 8: Estimated natural production of adult Winter Chinook Salmon from Calaveras River, and the Sacramento River Mainstem 1992-2016. Each graph provides the watershed's AFRP production target, estimated annual natural production of Chinook Salmon between 1992 and 2016, and average natural production of Chinook Salmon between 1967 and 1991. ↕

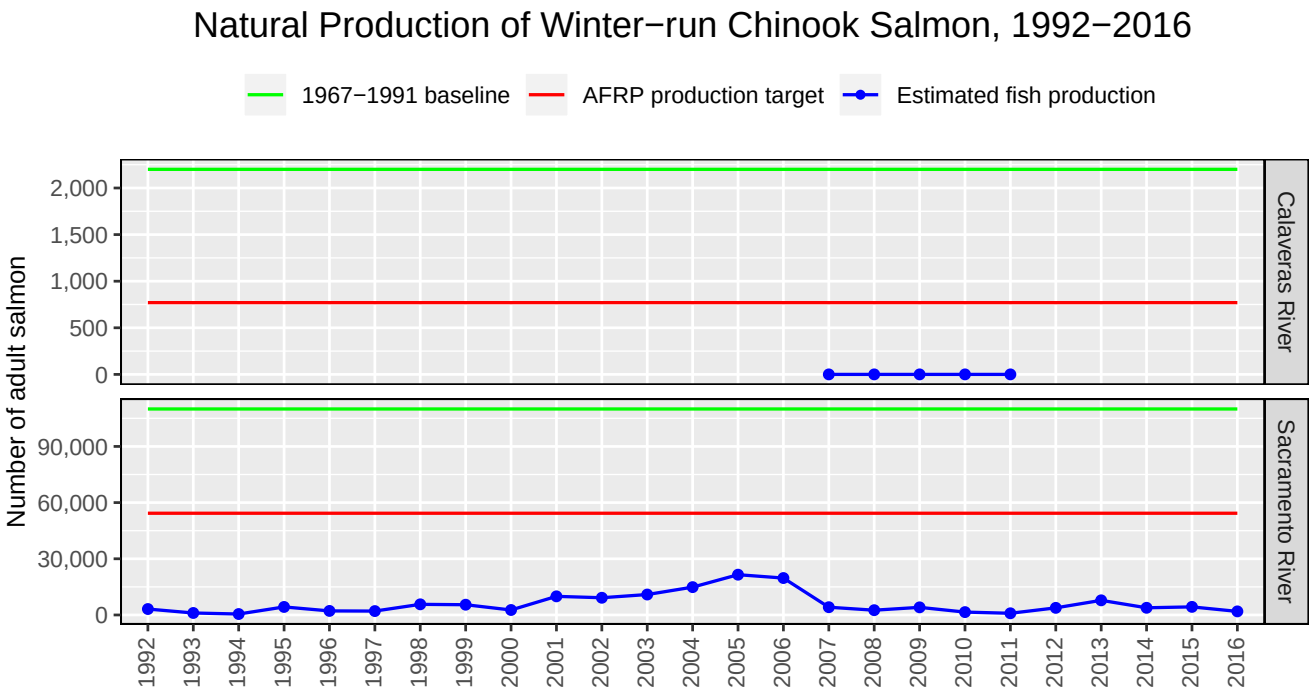
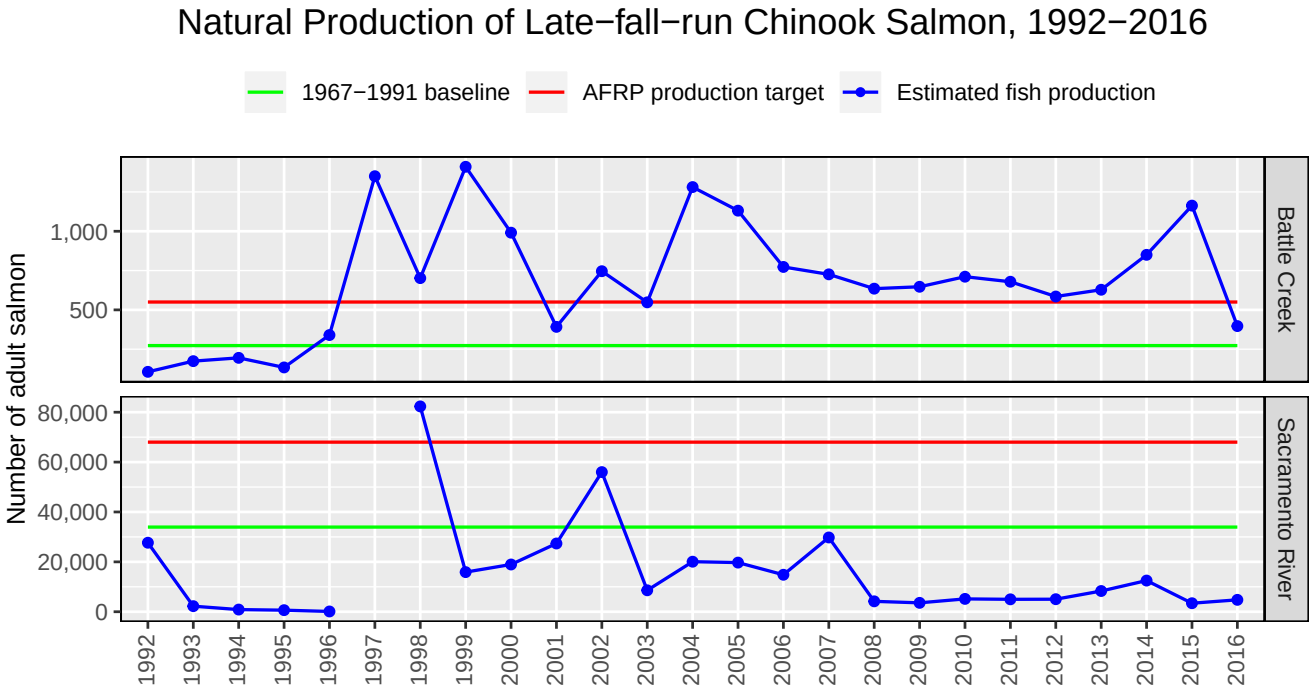


Figure 9: Estimated natural production of adult Late-fall Chinook Salmon from Battle Creek, and the Sacramento River Mainstem 1992-2016. Each graph provides the watershed's AFRP production target, estimated annual natural production of Chinook Salmon between 1992 and 2016, and average natural production of Chinook Salmon between 1967 and 1991. ↕



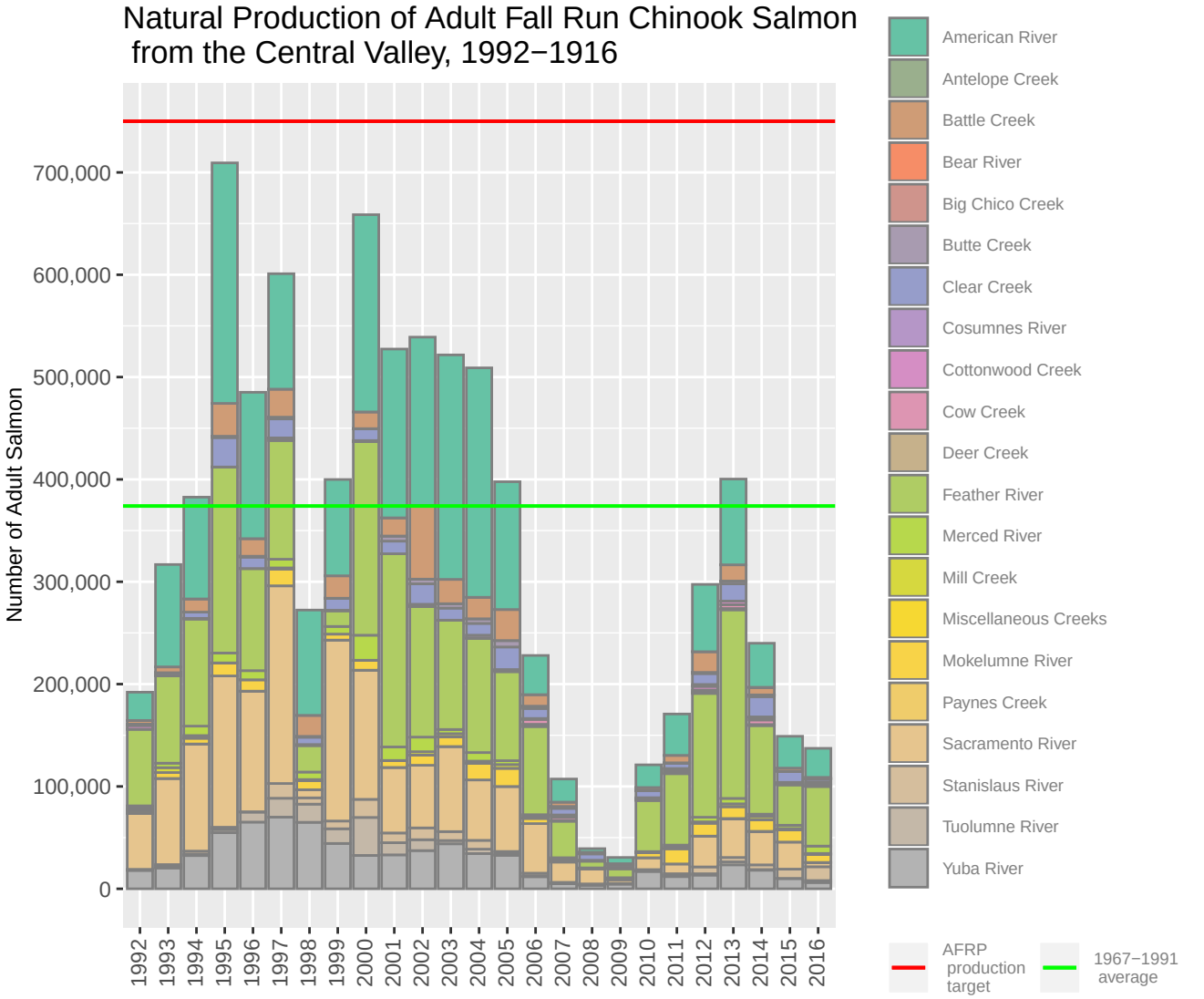
3.1.2 Production Estimates for Individual Runs

The production estimates for each of the four Chinook Salmon runs only include fish abundance estimates from watersheds and runs having an AFRP fish production target. (Table 1)

3.1.2.1 Fall-run Chinook Salmon

Estimates of the natural production of adult Fall-run Chinook Salmon from the Central Valley between 1992 and 2016 are presented in Table 2 and Figure 10. The estimates include the combined contributions from the aforementioned 21 watersheds with an AFRP Fall-run Chinook Salmon production target. The AFRP production target for adult Fall-run Chinook Salmon is 750,000 salmon. Salmon surveys in the Central Valley between 1992 and 2016 suggest the combined natural production of adult Fall-run Chinook Salmon from the 21 watersheds never equaled or exceeded this production target during that period.

Figure 10: Estimated natural production of adult Fall-run Chinook Salmon from the Central Valley, 1992-2016. Annual estimates of natural production reflect the combined contributions from 21 watersheds. The AFRP Fall-run Chinook Salmon production target is 750,000 Chinook Salmon, and the 1967-1991 baseline average is 374,049 Chinook Salmon.



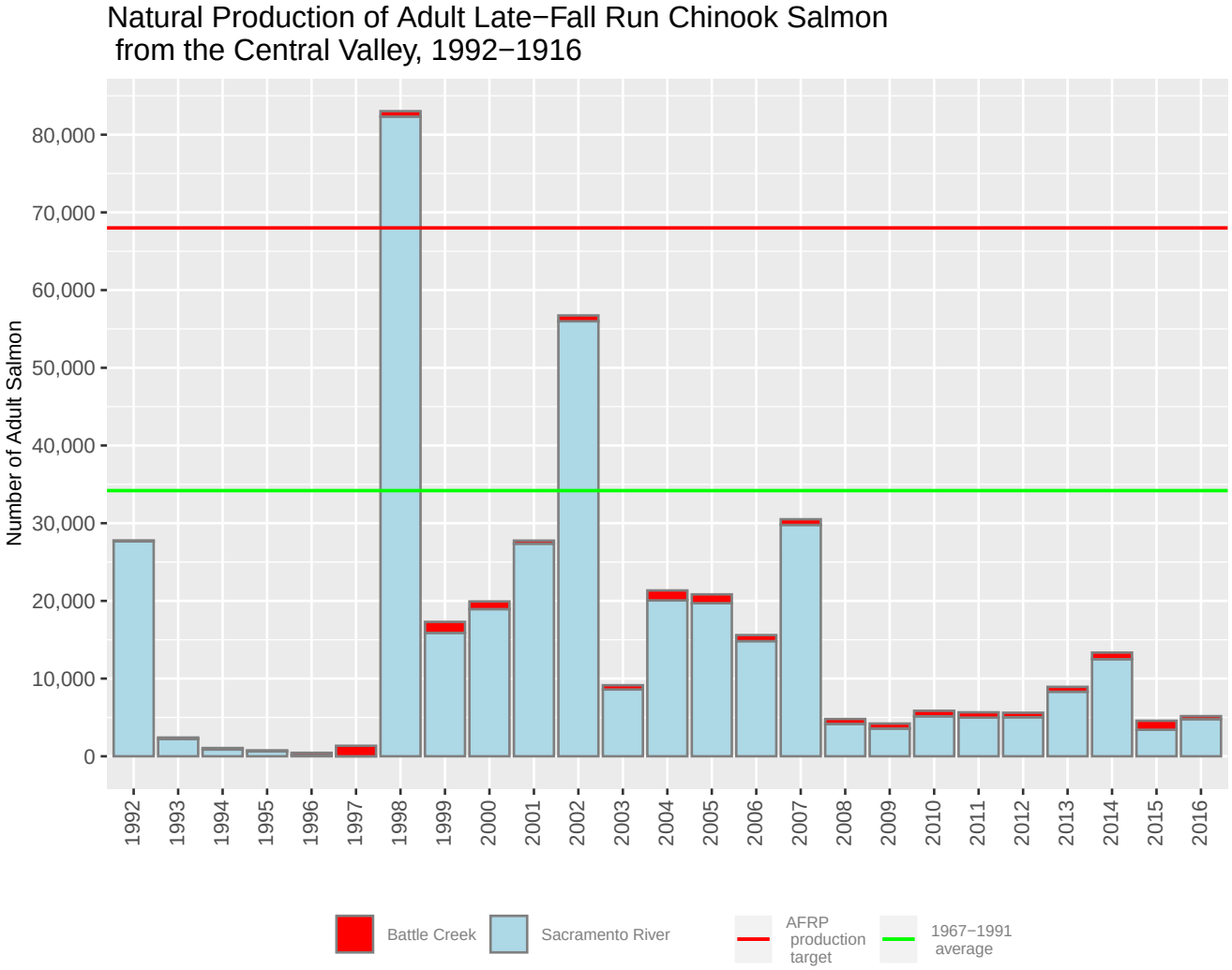
Between 1992 and 2016 and in descending order based on their average annual natural production during this period, the following watersheds consistently contributed the greatest number of fish to the

AFRP Fall-run Chinook Salmon production target: American River, Feather River, Sacramento River mainstem, Yuba River, and Battle Creek.

3.1.2.2 Late-fall-run Chinook Salmon

Estimates of the natural production of adult Late-fall-run Chinook Salmon from the Central Valley between 1992 and 2016 are presented in Table 2 and Figure 11. These production estimates include the combined contributions from Battle Creek and the Sacramento River mainstem. The AFRP production target for adult Late-fall-run Chinook Salmon is 68,000 salmon. Fish surveys indicate the combined natural production of adult Late-fall-run Chinook Salmon from Battle Creek and the Sacramento River mainstem met this production target once during that 25-year period (i.e., in 1998).

Figure 11: Estimated natural production of adult Late-fall-run Chinook Salmon from the Central Valley, 1992-2016. Annual estimates reflect the combined contributions from Battle Creek and the Sacramento River mainstem. The AFRP Late-fall-run Chinook Salmon production target is 68,000 Chinook Salmon, and the 1967-1991 baseline average is 34,192 Chinook Salmon.

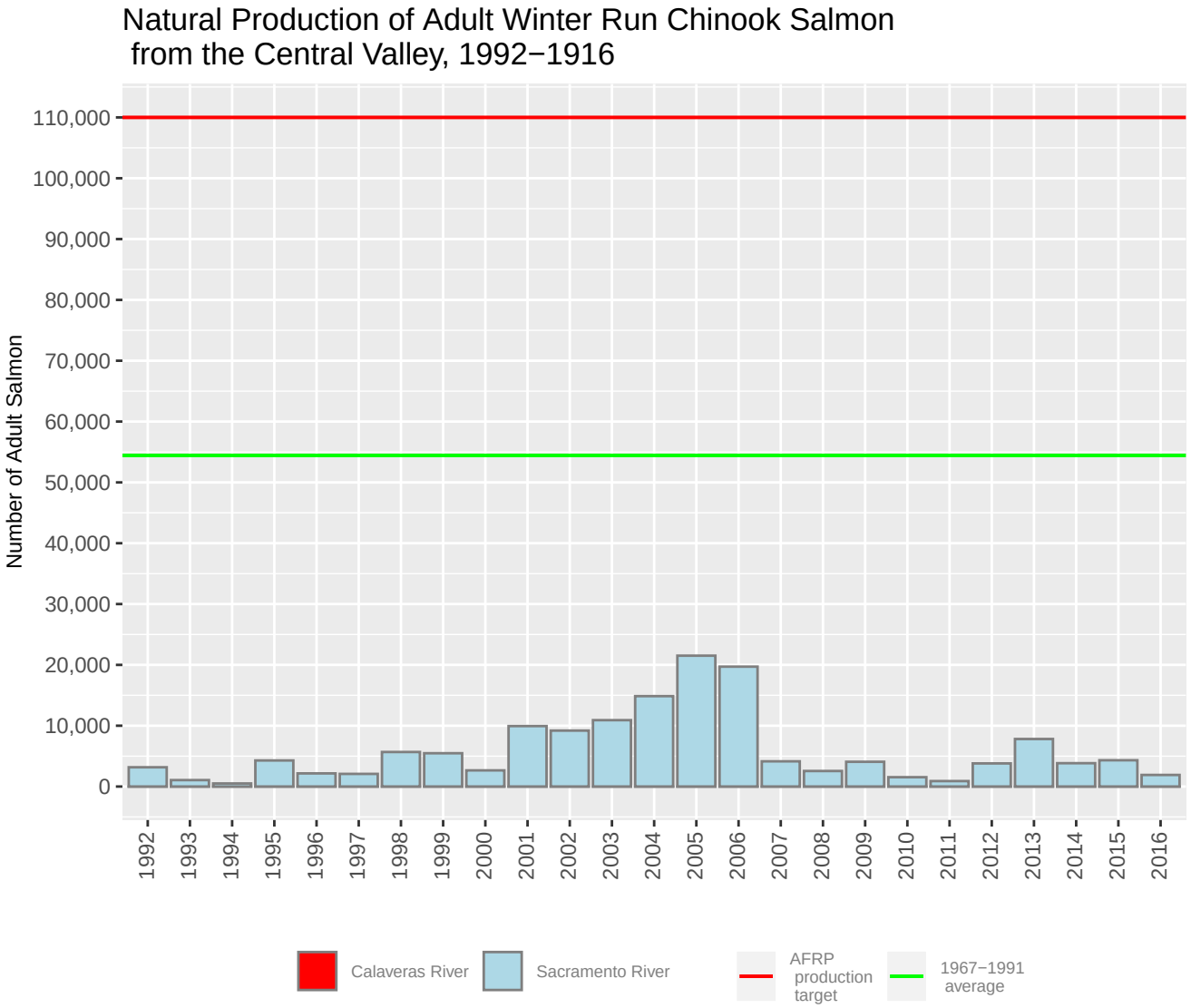


3.1.2.3 Winter-run Chinook Salmon

Estimates of the natural production of adult Winter-run Chinook Salmon from the Central Valley between 1992 and 2016 are presented in Table 2 and Figure 12. These production estimates consist of the combined contributions from the Calaveras River and Sacramento River mainstem. The AFRP production target for adult Winter-run Chinook Salmon is 110,000 salmon. Chinook Salmon surveys indicate the Winter-run Chinook Salmon production target between 1992 and 2016 was never met because: (1)

the Winter-run Chinook Salmon production from the Sacramento River mainstem since 1992 has been markedly below the AFRP's Winter-run Chinook Salmon production target, and (2) the historical Winter-run Chinook Salmon production from the Calaveras River, if any, was too small to contribute to the AFRP Winter-run Chinook Salmon production target in a substantial way.

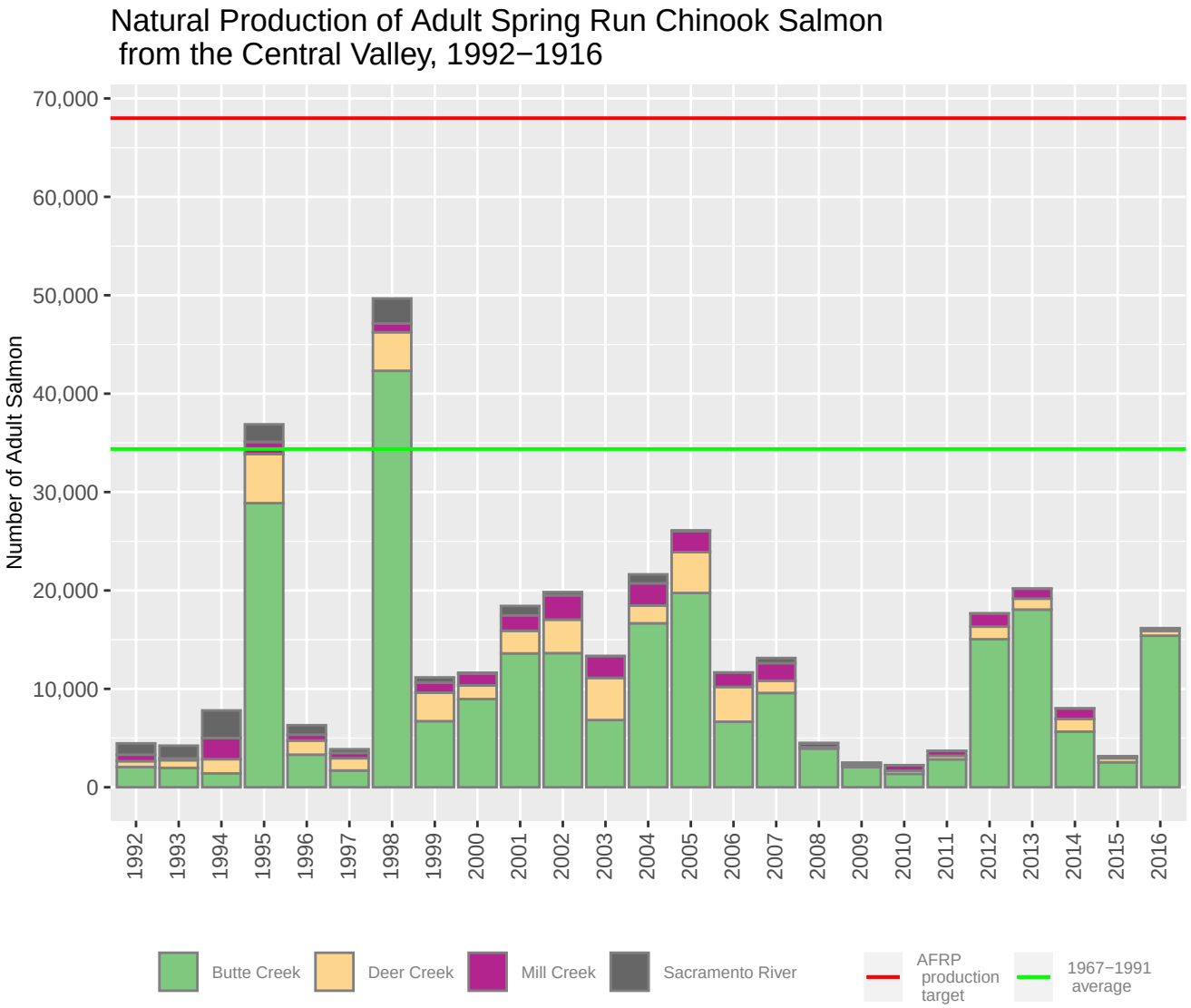
Figure 12: Estimated natural production of adult Winter-run Chinook Salmon from the Central Valley, 1992-2016. Annual estimates reflect the combined contributions from the Calaveras River and Sacramento River mainstem. The AFRP Winter-run Chinook Salmon production target is 110,000 Chinook Salmon, and the 1967-1991 baseline average is 54,439 Chinook Salmon.



3.1.2.4 Spring-run Chinook Salmon

Estimates of the natural production of adult Spring-run Chinook Salmon in the Central Valley between 1992 and 2016 are presented in Table 2 and Figure 13. The estimates include the combined contributions from Butte Creek, Deer Creek, Mill Creek, and the Sacramento River mainstem. The AFRP production target for adult Spring-run Chinook Salmon is 68,000 salmon. Surveys between 1992 and 2016 suggest the combined natural production of adult Spring-run Chinook Salmon from these four watersheds never equaled or exceeded this production target during that period.

Figure 13: Estimated natural production of adult Spring-run Chinook Salmon from the Central Valley, 1992-2016. Annual estimates reflect the combined contributions from Butte Creek, Deer Creek, Mill Creek, and the Sacramento River mainstem. The AFRP Spring-run Chinook Salmon production target is 68,000 Chinook Salmon, and the 1967-1991 baseline average is 34,374 Chinook Salmon.



3.1.3 Population Estimates for the Central Valley

Estimates of the combined natural production of all four runs of Chinook Salmon from the aforementioned 22 watersheds in the Central Valley between 1992 and 2016 are presented in Table 2 and Figure 14. The AFRP Central Valley-wide adult Chinook Salmon production target is 990,000 salmon. Chinook Salmon between 1992 and 2016 suggest this production target was never met during that 25-year period.

During the 25-year period between 1992 and 2016, the average contribution of the number of Fall, Late-fall, Winter, and Spring run Chinook Salmon to Central Valley-wide production was 85.5%, 3.2%, 1.1%, and 10.0%, respectively.

Figure 14: Estimated total natural production of adult Fall, Late-fall, Winter, and Spring run Chinook Salmon from the Central Valley, 1992-2016. Annual estimates reflect the combined total production of all four runs of Chinook Salmon from 22 watersheds. The AFRP Central Valley-wide production target for adult Chinook Salmon is 990,000 Chinook Salmon, and the 1967-1991 baseline average is 497,069 Chinook Salmon.

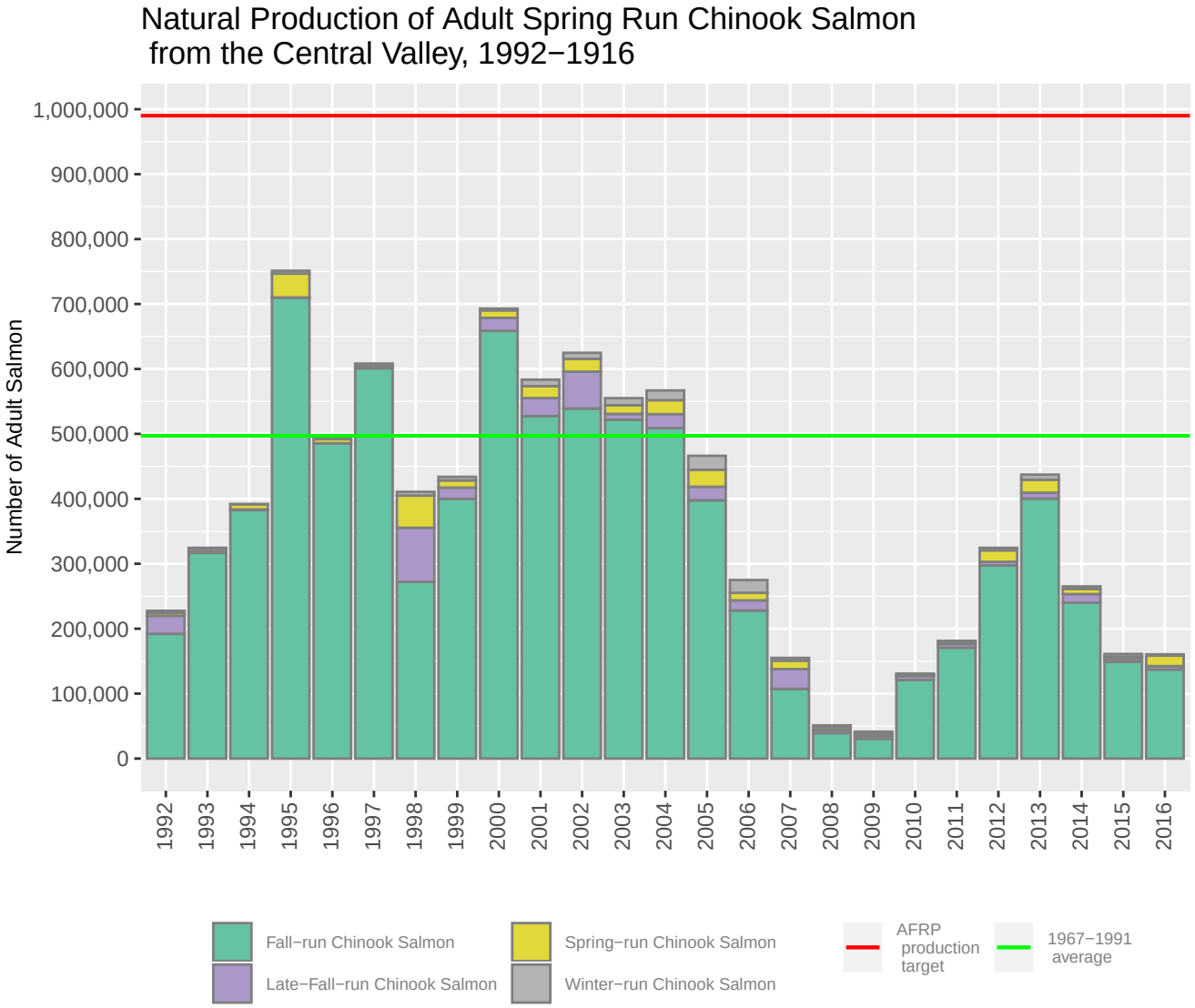
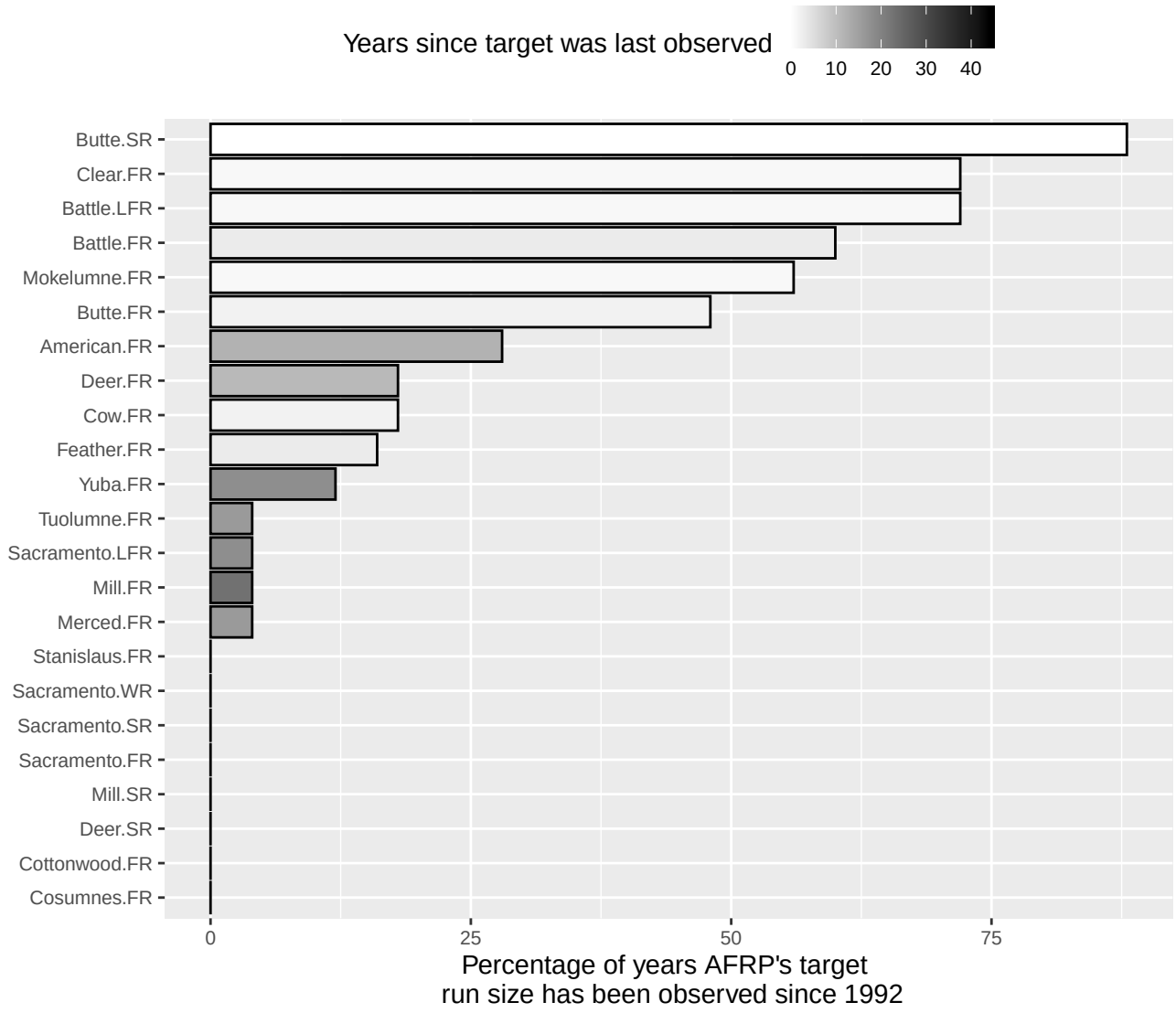


Figure 15: Bar chart showing the percentage of years since 1992 that Chinook Salmon escapement has reached at least 90% of the AFRP target for each stream. Only streams with at least 23 years of data since 1967, and at least 10 years since 1992, are graphed. The vertical access provides the stream followed by the salmon run: FR=Fall Run, LFR=Late Fall Run, SR=Spring Run, and WR=Winter Run. The chart's color shading indicates how long it has been since at least 90% of the AFRP target was met on each stream; the color scale ranges from 0 to 40 years prior to 2016 with darker colors representing longer time spans. The eight stream-run combinations that did not meet their AFRP target during 1992-2016 had not done so for at least 28 years prior to 2016 (i.e., 1988 or earlier).



3.1.4 Statistically Significant Changes in Natural Production of Chinook Salmon

The results of the model comparisons are shown in Table 4. Mann-Whitney U test results were included because this test had been used in previous CAMP annual reports. However, these test results may be inappropriate given the lack of independence of samples (Appendix A [5.1]). In general, the most complex model (M3) was the preferred model, although for the Spring Run return index the simpler models were not much different in terms of their ΔAIC values. Residuals were generally not correlated or otherwise appeared heterogeneous (Figure 19). To provide a concise interpretation of M3, the summary of model 1 parameter estimates for each dataset is shown in Table 5.

3.1.5 Cormack-Jolly-Seber Model Escapement Results

Tabular and graphical data with adult Chinook Salmon escapement estimates, confidence intervals, and coefficients of variation that are based on a Cormack-Jolly-Seber (CJS) mark recapture model since 2011 are provided in Appendix F (5.6). The 2016 values in the tables and graphs in Appendix F (5.6) are provisional and subject to change.

The watersheds where the CJS mark recapture model has been used to develop escapement estimates during carcass surveys include the American River, Butte Creek, Clear Creek, Feather River, Merced River, Sacramento River, Stanislaus River, and Tuolumne River. The watersheds where the CJS mark recapture model has been used to process video camera or video camera/redd survey data includes Battle Creek, Clear Creek, Cottonwood Creek, Cow Creek, Deer Creek, and Mill Creek. The CJS mark recapture model has been used to develop escapement estimates using VAKI or VAKI/carcass survey data from the Yuba River. Except for the Feather River where the CJS mark recapture model results include a combination of Fall and Spring run Chinook Salmon, the model results pertain to a single salmon run.

The CJS mark recapture model results suggest there typically was a steady increase in the escapement of adult Fall-run Chinook Salmon in several of the Central Valley watersheds from 2011 to 2013. In at least some of the watersheds in 2016, a decline in salmon escapement levels occurred relative to levels in 2013.

Unexpectedly, the coefficients of variation for escapement surveys in many of the watersheds where carcass surveys have been conducted in the Central Valley are unusually small, i.e., less than 0.050. Coefficients of variation during wildlife and fisheries population assessments are rarely this small, and their occurrence during the Central Valley Chinook Salmon escapement surveys is largely explained by the fact Central Valley biologists are collecting and marking a large majority of the dead salmon carcasses present in their respective watersheds (Ryan Nielson, West Inc., pers. comm.). The occurrence of small coefficients of variation also holds true for some watersheds where escapement surveys were done with cameras. The epitome of this case occurs on the Yuba River where VAKI cameras were successfully operated each day during four consecutive annual runs of spring Chinook Salmon (Duane Massa, PSMFC, pers. comm.), thereby producing a coefficient of variation of 0.000.

3.2 Production of Non-Salmonid Taxa

3.2.1 Production of Adult Striped Bass, Adult White and Green Sturgeon

For more information about Adult Striped Bass, Green Sturgeon and White Sturgeon visit the CAMP website page and refer to reports prior to 2016.

3.2.2 Production of Juvenile American Shad

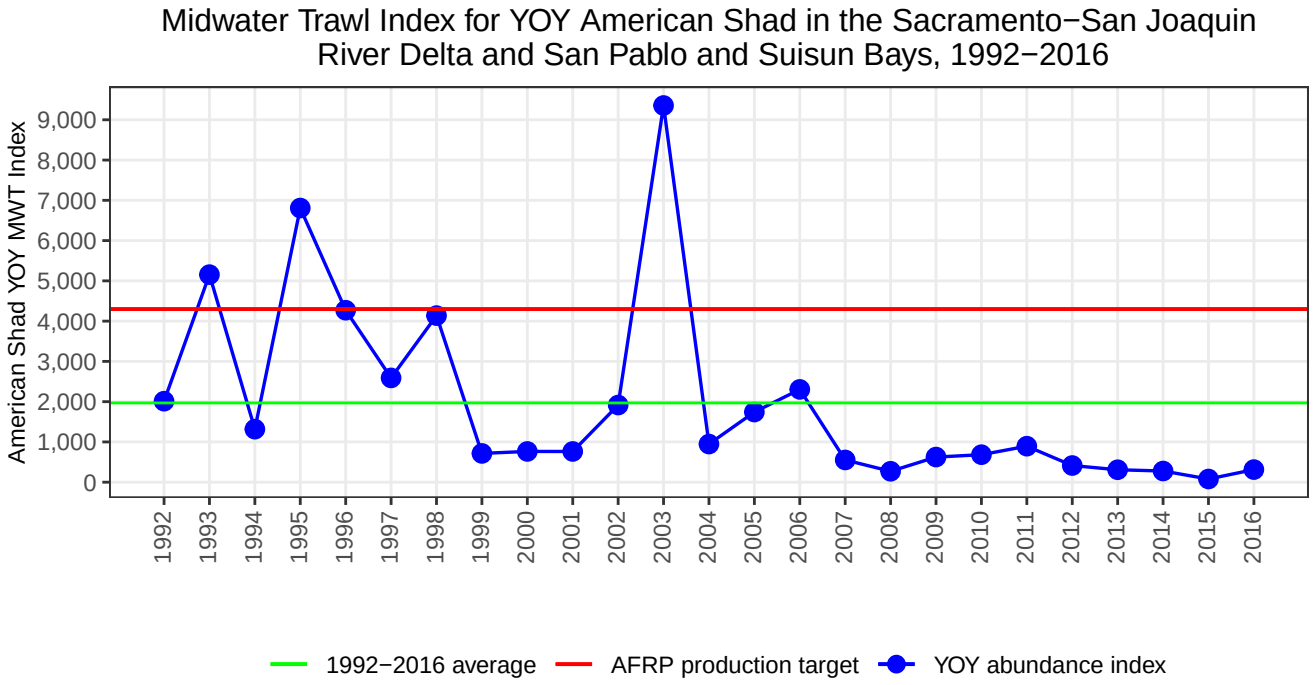
The annual Fall Midwater Trawl index for YOY American Shad in the Sacramento-San Joaquin River Delta and San Pablo and Suisun bays during the 1992-2016 time period ranged between 79 and 9,355 (Table 3). The AFRP production target for American Shad is 4,300 fish. Between 1992 and 2016, the FMWT YOY index exceeded the AFRP production target in 3 of 25 years (Figure 16). American Shad's FMWT index last met the AFRP target in 2003, in the early day's of the estuary's pelagic organism decline ([Sommer, T. and 13 co-authors, 2007]). Like several other pelagic fishes, its abundance indices have remained low since.

The FMWT YOY indices reported in this CAMP annual report are slightly different than the values reported in previous editions of the CAMP annual report. These differences exist because the data in previous reports inadvertently did not include the frequency of the adjusted fork length correction factors, but instead provided the count of the adjusted fork length correction factors. This error resulted in discrepancies in previous FMWT YOY indices that were on the order of 2-12 FMWT index units per year. These discrepancies were not large enough, however, to change the conclusion of how many years the AFRP production target was met.

Table 3: Fall Midwater Trawl index for young-of-the-year American Shad in the Sacramento-San Joaquin River Delta and San Pablo and Suisun bays, 1992-2016.

Year	FMWT index for young−of−the−year American Shad
1992	2,012
1993	5,155
1994	1,317
1995	6,808
1996	4,270
1997	2,590
1998	4,137
1999	715
2000	764
2001	763
2002	1,916
2003	9,355
2004	947
2005	1,742
2006	2,304
2007	552
2008	271
2009	624
2010	683
2011	894
2012	414
2013	309
2014	278
2015	79
2016	313

Figure 16: Fall Midwater Trawl index for young-of-the-year American Shad in the Sacramento-San Joaquin River Delta and San Pablo and Suisun bays, 1992-2016.



4 DISCUSSION

The "Discussion" section of this document provides an assessment of the overall (cumulative) effectiveness of habitat restoration actions implemented pursuant to Section 3406(b) of the CVPIA in meeting the AFRP production targets for eight anadromous fish taxa. These habitat restoration actions include water management modifications, structural modifications, habitat restoration, and fish screens.

As stated in the "Data Caveats" (1.3) section of this report, several inherent challenges or assumptions are associated with monitoring anadromous fish species in the Central Valley. These issues must be acknowledged as temporal changes in the production of anadromous fish are assessed. For example, monitoring activities for the eight taxa in a given location may not have been conducted with a standardized protocol and with the same level of effort over time. Developing definitive conclusions as to how fish production or abundance has changed over time is therefore difficult.

To the extent possible, this report attempts to synthesize data for the 1967-1991 and 1992-2016 time periods using the same analytical techniques and approaches. This effort should increase comparability of data collected during the two time periods and thereby increase the probability of making accurate inferences about changes in fish numbers. This report also provides the most current data available at the time of report production, i.e., the individuals that were responsible for collecting different data sets (e.g., American Shad) were contacted a few weeks prior to the development of this report to ensure that the most accurate, timely data were used to quantify fish abundance and population estimates.

4.1 Progress toward AFRP Production Targets for Chinook Salmon

The production of Chinook Salmon at fish hatcheries in the Central Valley makes it difficult to accurately monitor the natural production of Chinook Salmon. These facilities are located on the American River, Battle Creek, Feather River, Merced River, Mokelumne River, and Sacramento River mainstem. These hatcheries, with the exception of the Livingston Stone National Fish Hatchery on the Sacramento River mainstem, produced large numbers of unmarked juvenile Fall-run Chinook Salmon for many years

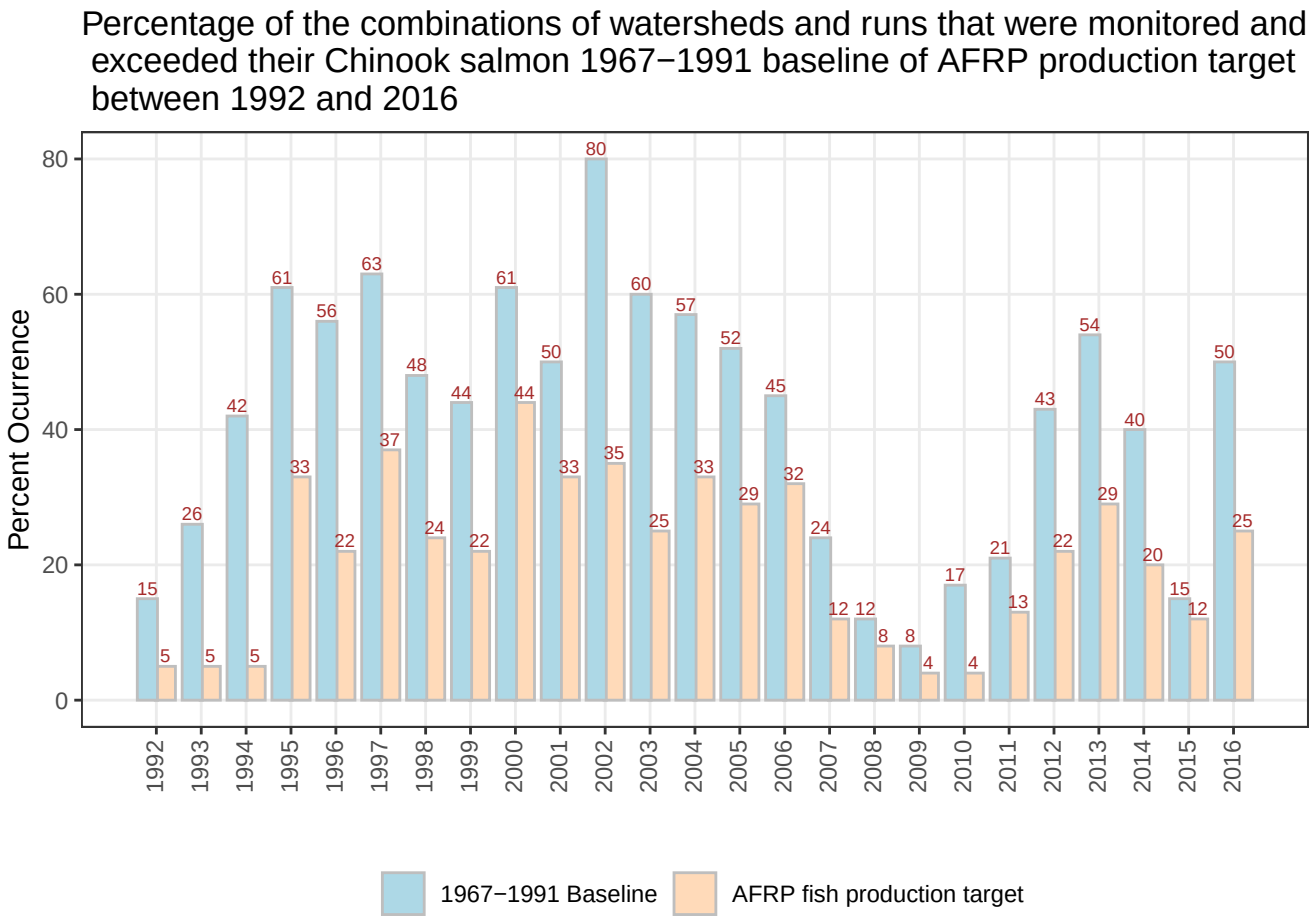
or decades prior to 2016. If hatchery-produced juvenile salmon are not marked prior to their release from a hatchery, it is difficult to identify these salmon when they return to a river to spawn as adults. This factor makes it difficult to accurately quantify the relative proportion of natural vs. hatchery origin Chinook Salmon in a watershed.

The calculations in the Chinookprod spreadsheet currently rely on "best professional judgments" in regard to the amount of in-river angler harvest and the estimated hatchery proportion in each watershed [U.S. Fish and Wildlife Service (USFWS), 1995]. The accuracy of the natural production estimates has been the subject of some debate, particularly in regard to the estimated hatchery proportions. An effort to lay the groundwork to accurately quantify the relative proportion of natural vs. hatchery origin Fall-run Chinook Salmon has occurred since 2007; this effort involves the marking and coded wire tagging of at least 25% of the Fall-run Chinook Salmon produced at fish hatcheries in the Central Valley. In 2016, many of the brood year 2012 and 2013 juvenile Fall-run Chinook Salmon that were marked during the Constant Fractional Marking Program returned to the Central Valley to spawn as 2 or 3 year-old adult fish. The collection and analysis of these coded wire tagged salmon is expected to provide an enhanced ability to quantify the hatchery proportion in different Central Valley rivers and streams, and more accurate production estimates using these hatchery proportions will be provided by the CAMP as these hatchery proportions become available.

The production of adult Fall-run Chinook Salmon steadily rose from 2011 to 2013, then declined in 2014 to 239,911 salmon. This suggests a steady rebuilding of that salmon stock following the marked decline that occurred between 2004 and 2009, and then a reversal in salmon production in the most recent year. As the production of adult Fall-run Chinook Salmon increased in recent years, the combined production of all four runs of adult Chinook Salmon in the Central Valley also increased because Fall-run Chinook Salmon predominate in their contribution to the Central Valley total. In 2016, the combined Central Valley-wide adult production of all four salmon runs was 160,466 salmon, vs. the 41,381 salmon produced in 2009.

There are 29 combinations of watersheds and runs of Chinook Salmon with an AFRP production target. Figure 17 illustrates the percentage of the combinations of watersheds and runs that were monitored and exceeded their Chinook Salmon 1967-1991 baseline level or their AFRP fish production target between 1992 and 2016. Figure 17 also illustrates the rebuilding of the Central Valley salmon stocks following the 2004-2009 salmon decline, and the two year decline in year over year production that occurred in 2015 and 2016. In 2009, only 8% (i.e., two) of the combinations of watersheds and runs that were monitored in the Central Valley exceeded their AFRP production target. In 2015, 16% (i.e., four watersheds) of the combinations of watersheds and runs that were monitored in the Central Valley exceeded their AFRP production target. For 2016, 16% of the combination of monitored watersheds and runs had production that at least equaled the level during the 1967-1991 baseline period.

Figure 17: Percentage of watersheds and runs that were monitored and exceeded their Chinook Salmon 1967-1991 baseline level or their AFRP fish production target between 1992 and 2016.



It is important to note that the post-2010 adoption of a Cormack-Jolly-Seber mark recapture model as adult Chinook Salmon escapement surveys are done is beginning to produce data that will provide a more statistically robust approach to assessing trends in the production of adult salmon. As additional years of data from the Cormack-Jolly-Seber mark recapture model become available, the CAMP will use this data to assess the significance of short-term changes in escapement trends of adult Chinook Salmon.

4.2 Progress toward AFRP Production Targets for Non-Salmonid Species

The 2016 Fall Midwater Trawl index for juvenile American Shad was 313. Because the vast majority of the core sampling stations used to calculate the FMWT index have been monitored on a consistent basis since 1967, the depressed FMWT index for juvenile American Shad is therefore likely to reflect an actual decline in fish numbers and probably is not an artifact of reduced sampling effort. That conclusion is further substantiated because the geographic distribution of the area sampled during the FMWT index has remained essentially unchanged since 1967.

5 APPENDICES

5.1 Appendix A: Trends in Adult Salmon Return Indices

OVERVIEW

↕ Annual salmon return indices from several different runs from 1967 to 2016 are used to assess if there is a difference in their trends between the time period 1967-1991 and 1992-2016. Time series plots of these returns are shown in Figure 18. Salmon life history would suggest a peak in the autocorrelation at a three year lag if spawner-recruit relationships were the primary source of correlation, but these were not observed and instead autocorrelation tends to taper off (Figure 19). A collection of generalized linear and additive models [Wood, 2017] were developed to study changes in mean values pre- and post-1992 In general, the patterns and analyses suggest that while there is significant change in the characterizations of the return distributions pre- and post-1992, they are not simple (e.g. as might be captured in an overall mean). Based on a log-linear model allowing a change beginning in 1992, only Fall pre-1992 and Winter post-1992 have shown positive trends through time, and in all other cases the trend beginning in 1992 has grown more negative, although not always significantly.

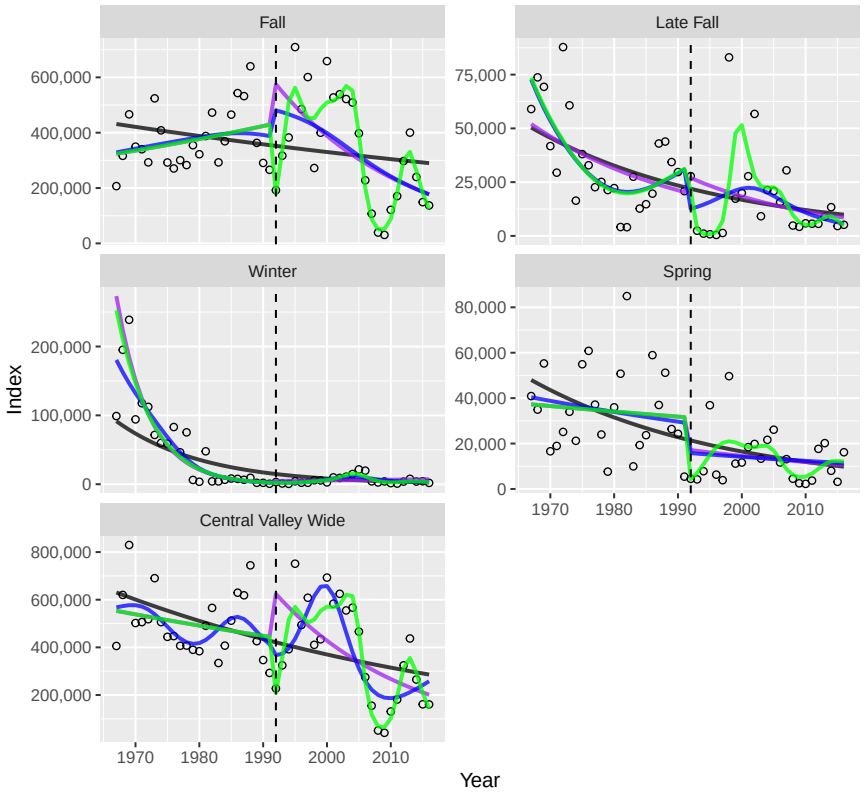


Figure 18: Return indices (open circles) and model predictions (lines) for model predictions M0 (black), M1 (purple), M2 (blue), and M3 (green). A dashed vertical line is drawn at 1992.↕

METHODS

To evaluate potential changes in statistical properties of the indices pre- and post- 1992, four models were fit with increasing complexity, and accordingly increasing difficulty in making simple statements about differences between the two time periods. All models assumed the data were gamma distributed with mean values modeled on the log scale. The primary difference was how the mean through time is modeled. For modeling purposes, the 50 years of time from 1967-2016 indexed by $T = \{1, ..., 50\}$ were

grouped into two sets each of length 50, $T^{(1)} = \{1,...,25,0,....,0\}$ with nonzero values corresponding to 1967-1991, and $T^{(2)} = \{0,...0,1,...,25\}$ with nonzero values corresponding to 1992-2016. The log predicted values p are:

- M0. A null model whose mean is described as a linear line,

$$log(p) = b0 + b1 * T \tag{1}$$

- M1. The mean is described by a linear line with a change in intercept and slope beginning in 1992,

$$log(p) = b0 + b2 * T^{(1)} + I_{T>1991}(b1 + b3 * T^{(2)}) \tag{2}$$

- M2. The mean is described by a single non-linear smooth in time with a level shift beginning in 1992,

$$log(p) = b0 + s(T) + I_{T>1991} b1 \tag{3}$$

- M3. The mean is described by two separate non-linear smooths, one for the pre-1992 time period, and one for after,

$$log(p) = I_{T<1992}(b0 + s_1(T^{(1)})) + I_{T>1991}(b1 + s_2(T^{(2)})) \tag{4}$$

RESULTS

The results of the models are shown in Table 4 below, along with the Mann-Whitney U test (acknowledging this test may be inappropriate given lack of independence of samples). In general, the most complex model (M3) was the preferred model, although for the Spring return index the simpler models were not much different in terms of their AIC values. The mean predictions are shown in Figure 18. Residuals were generally not correlated or otherwise appeared heterogeneous (Figure 19). To provide a somewhat easy interpretation, the summary of model M2 parameter estimates for each dataset is shown in Table 5.

Table 4: Table summarizing Mann-Whitney U p-values (MW) and ΔAIC values for the four models, rounded to the nearest hundredth.

Data	MW	ΔAIC			
		M0	M1	M2	M3
Fall	0.44	61.70	55.12	53.90	0.00
Late Fall	0.00	30.61	34.20	27.57	0.00
Winter	0.00	46.17	20.10	6.08	0.00
Spring	0.00	3.78	5.27	3.50	0.00
Central Valley Wide	0.04	57.87	55.58	46.52	0.00

Table 5: Parameter estimate summary for the log-linear models with a change in intercept and slope beginning in 1992, on the log scale. Parameters b0 and b2 are the intercept and slope parameters for the pre-1992 time period, and b1 and b3 are changes to the pre-1992 intercept and slope parameters that produce the post-1992 time period values. Est- estimate, StdErr- standard error, both on the log-scale.

Data	Parameter	Est	StdErr	t-value	P-value
Fall	b0	12.68	0.17	74.00	0.00
Fall	b1	0.64	0.24	2.62	0.01
Fall	b2	0.01	0.01	1.02	0.31
Fall	b3	-0.06	0.02	-3.73	0.00
Late Fall	b0	10.90	0.34	32.08	0.00
Late Fall	b1	-0.65	0.48	-1.35	0.18
Late Fall	b2	-0.04	0.02	-1.71	0.09
Late Fall	b3	-0.01	0.03	-0.27	0.78
Winter	b0	12.72	0.35	36.84	0.00
Winter	b1	-4.26	0.49	-8.73	0.00
Winter	b2	-0.20	0.02	-8.49	0.00
Winter	b3	0.21	0.03	6.54	0.00
Spring	b0	10.53	0.29	36.47	0.00
Spring	b1	-0.76	0.41	-1.87	0.07
Spring	b2	-0.01	0.02	-0.35	0.73
Spring	b3	-0.01	0.03	-0.49	0.62
Central Valley Wide	b0	13.23	0.16	80.59	0.00
Central Valley Wide	b1	0.16	0.23	0.68	0.50
Central Valley Wide	b2	-0.01	0.01	-0.83	0.41
Central Valley Wide	b3	-0.04	0.02	-2.44	0.02

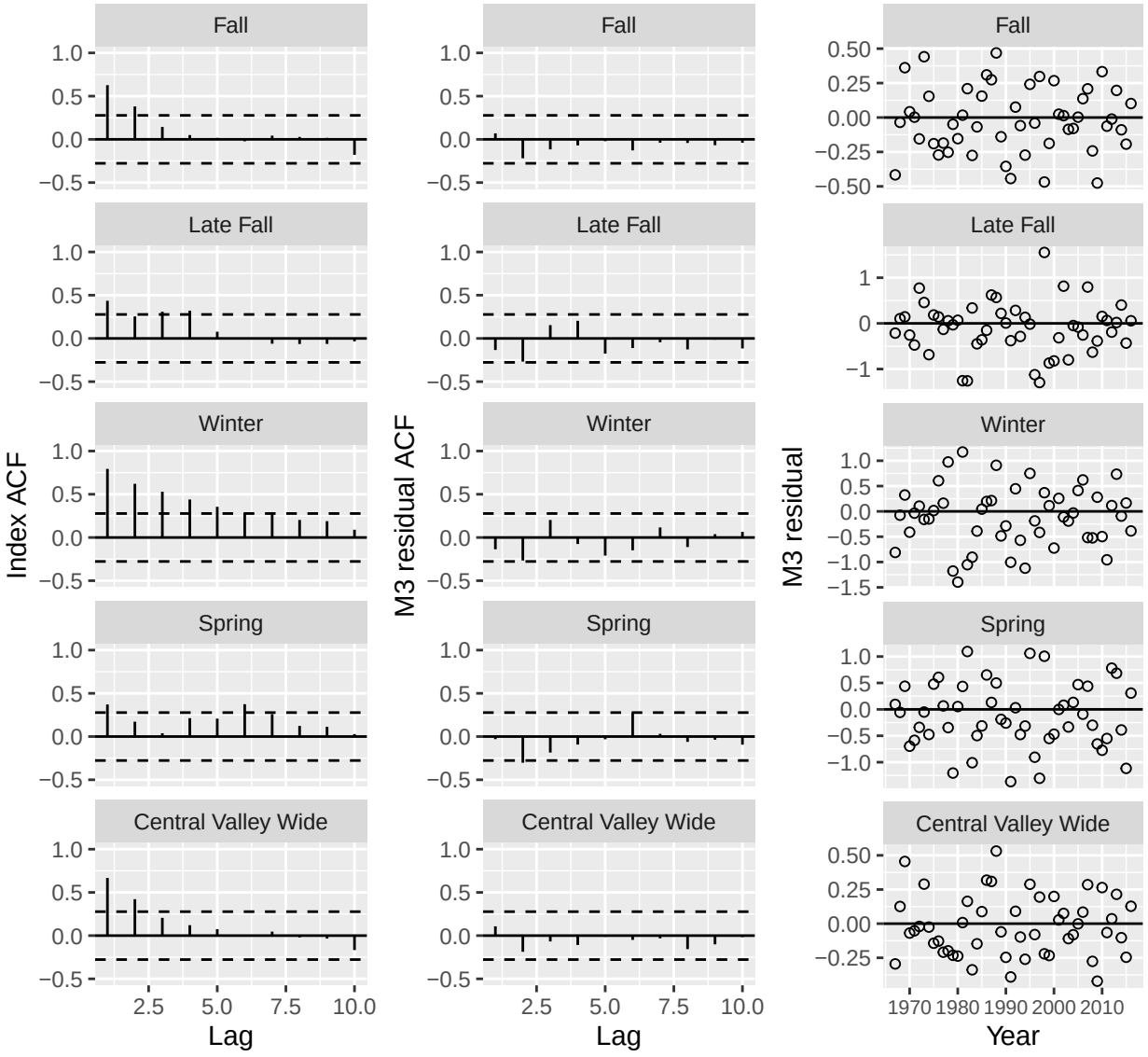


Figure 19: Panels show autocorrelation data (left column), model M3 residuals (middle column), and year specific values (right column), by water basin.

REMARKS

- From an ARIMA modeling perspective, the indices appear to be best described as $ARIMA(p = 1, d = 1, q = 1)$ or with higher q values. This suggests that correlation between close in time index values could be modeled using correlated noise terms. Similarly, while the residuals of the M3 models appear to be iid, with the exception of the Spring return index model M2 residuals appeared to still show some autocorrelation but no partial-autocorrelation.

- Using a Gaussian rather than a gamma distribution for the response variable was usually better based on an AIC comparison, withe the exception of the M3 models. Although they have the same number of parameters, the gamma distribution allows only positive predictions but also assumes a specific mean-variance relationship. A more exhaustive analysis might compare these and other more complicated variance models.

5.2 Appendix B: Ocean Harvest Estimates of Chinook Salmon

Chinook Salmon ocean harvest data reflect the number of salmon captured by commercial and recreation boats based in San Francisco and Monterey (PFMC 2017).

Year	Commercial harvest for San Francisco	Recreational harvest for San Francisco	Commercial harvest for Monterey	Recreational harvest for Monterey	Total ocean harvest attributable to the Central Valley
1992	95,800	47,193	64,500	19,526	227,019
1993	154,999	78,733	104,663	20,584	358,979
1994	219,856	140,977	70,508	24,835	456,176
1995	357,486	155,677	313,112	198,875	1,025,150
1996	167,379	84,471	181,467	44,812	478,129
1997	253,484	123,974	228,731	84,427	690,616
1998	126,120	70,969	95,433	43,468	335,990
1999	180,960	69,251	78,709	7,140	336,060
2000	250,368	64,653	197,184	81,782	593,987
2001	136,630	39,856	35,940	20,039	232,465
2002	242,872	87,008	69,980	47,703	447,563
2003	202,876	56,616	36,099	13,126	308,717
2004	298,229	130,220	64,707	44,845	538,001
2005	170,531	72,824	117,408	30,706	391,469
2006	47,689	54,926	11,204	10,970	124,789
2007	75,254	16,796	14,009	6,261	112,320
2008	0	0	0	0	0
2009	0	0	0	0	0
2010	1,105	6,116	1,430	6,295	14,946
2011	21,912	19,734	6,414	12,703	60,763
2012	119,100	46,189	52,972	30,364	248,625
2013	143,654	61,291	27,637	10,634	243,216
2014	82,424	32,453	8,308	14,020	137,205
2015	35,696	25,227	14,713	3,070	78,706
2016	26,275	26,308	13,227	1,335	67,145

5.3 Appendix C: Angler Regulations That Affected the Harvest of Adult Chinook Salmon Between 2008 and 2016

Because restrictions on ocean and in-river harvest of adult Chinook Salmon affect the natural production estimates developed by the USFWS, a synopsis of angler harvest restrictions between 2008 and 2016 are provided below.

The California Department of Fish and Wildlife's Central Valley Angler Survey Program does not assign salmon run to the adult salmon data it collects and reports.

In 2008 and 2009, the Chinook Salmon ocean harvest season was closed because there was concern about abnormally low numbers of adult Fall-run Chinook Salmon that originated in California's Central Valley. Because California's Fish and Game Commission authorized limited in-river harvest seasons in 2008 and 2009, CAMP staff have assumed that the start dates for those seasons were selected to avoid a period when adult Fall-run Chinook Salmon were likely to be present, i.e., the harvest season start date can be used to infer when Fall-run Chinook Salmon and Late-fall-run Chinook Salmon were likely present. While such an inference oversimplifies the biological reality that there is a period when both runs could be present in a watershed due to overlapping periods in run timing, the approach makes it possible to infer which salmon runs were principally being harvested during different harvest periods. Because the 2008 start date for in-river angler harvest began on November 1, CAMP staff have attributed the tables below so salmon harvested on or before October 31 are Fall-run Chinook Salmon, and salmon harvested on or after November 1 are Late-fall-run Chinook Salmon.

2008 Angler Harvest Restrictions

Year	Targeted salmon run	Watershed	Dates open to salmon harvest
2008	fall−run	Closed everywhere.	none
2008	late−fall−run	late−fall−run Middle Sacramento River, Red Bluff Diversion Dam to Knights Landing.	Nov. 1 to Dec. 31

2009 Angler Harvest Restrictions

Year	Targeted salmon run	Watershed	Dates open to salmon harvest
2009	fall−run	Closed everywhere.	none
2009	late−fall−run	late−fall−run Middle Sacramento River, Red Bluff Diversion Dam to Knights Landing.	Nov. 16 to Dec. 31

In 2008 and 2009, the harvest of Chinook Salmon in the Pacific Ocean along the California coastline by commercial and recreational anglers was prohibited, and inland river harvest was limited to a brief season for Late-fall-run Chinook Salmon in the Sacramento River.

2010 Angler Harvest Restrictions ↕

Year	Targeted salmon run	Watershed	Dates open to salmon harvest
2010	fall− and/or late−fall−run	American River, Ancil Hoffman Park to American River mouth.	Oct. 30 to Nov. 28
2010	fall−run	Feather River, Thermiloto Afterbay Outlet to Feather River mouth.	July 31 to August 29
2010	fall−run	Upper Sacramento River, Deschutes Road Bridge (Anderson) to 500 feet upstream of Red Bluff Diversion Dam.	Oct. 9 to Oct. 31
2010	fall− and/or late−fall−run	Middle Sacramento River, Lower Red Bluff Boat Ramp to Hwy 133 Bridge (Knights Landing).	Oct. 9 to Dec. 12
2010	fall−run	Lower Sacramento River, Carquinez Straight to Hwy 133 Bridge (Knights Landing).	Sept. 4 to Oct. 3

In 2010, an abbreviated ocean harvest season for Chinook Salmon along the California coastline by commercial and recreational anglers was authorized as follows:

(1) Two four-day periods were open to commercial anglers in July south of Point Arena, and an additional fishery was authorized in the Fort Bragg area during late July and August, and

(2) Recreational anglers were allowed to harvest Chinook Salmon seven days per week between April 3 and 30, and Thursday through Monday between May 1 and September 6.

In 2010, an abbreviated inland river harvest of adult Fall- and/or Late-fall-run Chinook Salmon was authorized on portions of the American River, Feather River, and Sacramento River.

2011 Angler Harvest Restrictions ↕

Year	Targeted salmon run	Watershed	Dates open to salmon harvest
2011	fall− and/or late−fall−run	American River, from Nimbus Dam to the Hazel Avenue bridge piers.	July 16 to Dec. 31
2011	fall−run	American River, from Hazel Avenue bridge piers to the U.S. Geological Survey gauging station cable crossing about 300 yards downstream from the Nimbus Hatchery fish rack site.	July 16 to Sept. 14
2011	fall−run	American River, from the U.S. Geological Survey gauging station cable crossing about 300 yards downstream from the Nimbus Hatchery fish rack site to the SMUD power line crossing at the southwest boundary of Ancil Hoffman Park.	July 16 to Oct. 31.
2011	fall− and/or late−fall−run	American River, from the SMUD power line crossing at the southwest boundary of Ancil Hoffman Park downstream to the Jibboom Street bridge.	July 16 to Dec. 31
2011	fall− and/or late−fall−run	American River, from the Jibboom Street bridge to the mouth.	July 16 to Dec. 11.
2011	fall− and/or late−fall−run	Feather River, from 1,000 feet below the Thermalito Afterbay Outfall to the mouth.	July 16 to Dec 11.
2011	fall− and/or late−fall−run	Upper Sacramento River, Deschutes Road Bridge to 500 feet upstream from Red Bluff Diversion Dam.	Aug. 1 to Dec. 18.
2011	fall− and/or late−fall−run	Middle Sacramento River, 150 feet below the Lower Red Bluff Boat Ramp to Hwy 113 Bridge (Knights Landing).	July 16 to Dec. 18.
2011	fall− and/or late−fall−run	Lower Sacramento River, from the Hwy 113 bridge near Knights Landing to the Carquinez Bridge.	July 16 to Dec. 11.

In 2011, the ocean harvest of Chinook Salmon off the California coastline was similar to years prior to 2008, and inland river harvest of adult Fall- and/or Late-fall-run Chinook Salmon was authorized on portions of the American River, Feather River, and Sacramento River.

2012 Angler Harvest Restrictions ↕

Year	Targeted salmon run	Watershed	Dates open to salmon harvest
2012	fall− and/or late−fall−run	American River, from Nimbus Dam to the Hazel Avenue bridge piers.	July 16 to Dec. 31.
2012	fall−run	American River, from Hazel Avenue bridge piers to the U.S. Geological Survey gauging station cable crossing about 300 yards downstream from the Nimbus Hatchery fish rack site.	July 16 to August 15
2012	fall−run	American River, from the U.S. Geological Survey gauging station cable crossing about 300 yards downstream from the Nimbus Hatchery fish rack site to the SMUD power line crossing at the southwest boundary of Ancil Hoffman Park.	July 16 to Oct. 31.
2012	fall− and/or late−fall−run	American River, from the SMUD power line crossing at the southwest boundary of Ancil Hoffman Park downstream to the Jibboom Street bridge.	July 16 to Dec. 31.
2012	fall− and/or late−fall−run	American River, from the Jibboom Street bridge to the mouth.	July 16 to Dec. 16.
2012	fall−run	Feather River, from the unimproved boat ramp above the Thermalito Afterbay Outfall to 200 yards above the Live Oak boat ramp.	July 16 to Oct. 15.
2012	fall− and/or late−fall−run	Feather River, from 200 yards above Live Oak boat ramp to the mouth.	July 16 to Dec. 16.
2012	fall−run	Mokelumne River, From Camanche Dam to Highway 99 bridge.	July 16 to Oct. 15.
2012	fall− and/or late−fall−run	Mokelumne River, From the Highway 99 bridge to the Woodbridge Irrigation District Dam including Lodi Lake.	July 16 through Dec. 31.
2012	fall− and/or late−fall−run	Mokelumne River, From the Lower Sacramento Road bridge to the mouth.	July 16 through Dec. 16.
2012	fall− and/or late−fall−run	Upper Sacramento River, Deschutes Road Bridge to 500 feet upstream from Red Bluff Diversion Dam.	Aug. 1 to Dec. 16.
2012	fall− and/or late−fall−run	Middle Sacramento River, 150 feet below the Lower Red Bluff Boat Ramp to Hwy 113 Bridge (Knights Landing).	July 16 to Dec. 16.
2012	fall− and/or late−fall−run	Lower Sacramento River, from the Hwy 113 bridge near Knights Landing to the Carquinez Bridge.	July 16 to Dec. 16.

In 2012, the ocean harvest of Chinook Salmon off the California coastline was similar to years prior to 2008, and inland river harvest of adult Fall- and/or Late-fall-run Chinook Salmon was authorized on portions of the American, Feather, Mokelumne, and Sacramento Rivers.

2013 Angler Harvest Restrictions ↕

Year	Targeted salmon run	Watershed	Dates open to salmon harvest
2013	fall− and/or late−fall−run	American River, from Nimbus Dam to the Hazel Avenue bridge piers.	July 16 to Dec. 31.
2013	fall−run	American River, from Hazel Avenue bridge piers to the U.S. Geological Survey gauging station cable crossing about 300 yards downstream from the Nimbus Hatchery fish rack site.	July 16 to August 15
2013	fall−run	American River, from the U.S. Geological Survey gauging station cable crossing about 300 yards downstream from the Nimbus Hatchery fish rack site to the SMUD power line crossing at the southwest boundary of Ancil Hoffman Park.	July 16 to Oct. 31.
2013	fall− and/or late−fall−run	American River, from the SMUD power line crossing at the southwest boundary of Ancil Hoffman Park downstream to the Jibboom Street bridge.	July 16 to Dec. 31.
2013	fall− and/or late−fall−run	American River, from the Jibboom Street bridge to the mouth.	July 16 to Dec. 16.
2013	fall−run	Feather River, from the unimproved boat ramp above the Thermalito Afterbay Outfall to 200 yards above the Live Oak boat ramp.	July 16 to Oct. 15.
2013	fall− and/or late−fall−run	Feather River, from 200 yards above Live Oak boat ramp to the mouth.	July 16 to Dec. 16.
2013	fall−run	Mokelumne River, From Camanche Dam to Highway 99 bridge.	July 16 to Oct. 15.
2013	fall− and/or late−fall−run	Mokelumne River, From the Highway 99 bridge to the Woodbridge Irrigation District Dam including Lodi Lake.	July 16 through Dec. 31.
2013	fall− and/or late−fall−run	Mokelumne River, From the Lower Sacramento Road bridge to the mouth.	July 16 through Dec. 16.
2013	fall− and/or late−fall−run	Upper Sacramento River, Deschutes Road Bridge to 500 feet upstream from Red Bluff Diversion Dam.	Aug. 1 to Dec. 16.
2013	fall− and/or late−fall−run	Middle Sacramento River, 150 feet below the Lower Red Bluff Boat Ramp to Hwy 113 Bridge (Knights Landing).	July 16 to Dec. 16.
2013	fall− and/or late−fall−run	Lower Sacramento River, from the Hwy 113 bridge near Knights Landing to the Carquinez Bridge.	July 16 to Dec. 16.

In 2013, the ocean harvest of Chinook Salmon off the California coastline was similar to years prior to 2008, and inland river harvest of adult Fall- and/or Late-fall-run Chinook Salmon was authorized on portions of the American, Feather, Mokelumne, and Sacramento Rivers.

2014 Angler Harvest Restrictions ↕

Year	Targeted salmon run	Watershed	Dates open to salmon harvest
2014	fall− and/or late−fall−run	American River, from Nimbus Dam to the Hazel Avenue bridge piers.	July 16 to Dec. 31.
2014	fall−run	American River, from Hazel Avenue bridge piers to the U.S. Geological Survey gauging station cable crossing about 300 yards downstream from the Nimbus Hatchery fish rack site.	July 16 to August 15
2014	fall−run	American River, from the U.S. Geological Survey gauging station cable crossing about 300 yards downstream from the Nimbus Hatchery fish rack site to the SMUD power line crossing at the southwest boundary of Ancil Hoffman Park.	July 16 to Oct. 31.
2014	fall− and/or late−fall−run	American River, from the SMUD power line crossing at the southwest boundary of Ancil Hoffman Park downstream to the Jibboom Street bridge.	July 16 to Dec. 31.
2014	fall− and/or late−fall−run	American River, from the Jibboom Street bridge to the mouth.	July 16 to Dec. 16.
2014	fall−run	Feather River, from the unimproved boat ramp above the Thermalito Afterbay Outfall to 200 yards above the Live Oak boat ramp.	July 16 to Oct. 15.
2014	fall− and/or late−fall−run	Feather River, from 200 yards above Live Oak boat ramp to the mouth.	July 16 to Dec. 16.
2014	fall−run	Mokelumne River, From Camanche Dam to Highway 99 bridge.	July 16 to Oct. 15.
2014	fall− and/or late−fall−run	Mokelumne River, From the Highway 99 bridge to the Woodbridge Irrigation District Dam including Lodi Lake.	July 16 through Dec. 31.
2014	fall− and/or late−fall−run	Mokelumne River, From the Lower Sacramento Road bridge to the mouth.	July 16 through Dec. 16.
2014	fall− and/or late−fall−run	Upper Sacramento River, Deschutes Road Bridge to 500 feet upstream from Red Bluff Diversion Dam.	Aug. 1 to Dec. 16.
2014	fall− and/or late−fall−run	Middle Sacramento River, 150 feet below the Lower Red Bluff Boat Ramp to Hwy 113 Bridge (Knights Landing).	July 16 to Dec. 16.
2014	fall− and/or late−fall−run	Lower Sacramento River, from the Hwy 113 bridge near Knights Landing to the Carquinez Bridge.	July 16 to Dec. 16.

In 2014, the ocean harvest of Chinook Salmon off the California coastline was similar to years prior to 2008, and inland river harvest of adult Fall- and/or Late-fall-run Chinook Salmon was authorized on portions of the American, Feather, Mokelumne, and Sacramento Rivers.

2015 Angler Harvest Restrictions ↕

Year	Targeted salmon run	Watershed	Dates open to salmon harvest
2015	fall− and/or late−fall−run	American River, from Nimbus Dam to the Hazel Avenue bridge piers.	July 16 to Dec. 31.
2015	fall−run	American River, from Hazel Avenue bridge piers to the U.S. Geological Survey gauging station cable crossing about 300 yards downstream from the Nimbus Hatchery fish rack site.	July 16 to August 15
2015	fall−run	American River, from the U.S. Geological Survey gauging station cable crossing about 300 yards downstream from the Nimbus Hatchery fish rack site to the SMUD power line crossing at the southwest boundary of Ancil Hoffman Park.	July 16 to Oct. 31.
2015	fall− and/or late−fall−run	American River, from the SMUD power line crossing at the southwest boundary of Ancil Hoffman Park downstream to the Jibboom Street bridge.	July 16 to Dec. 31.
2015	fall− and/or late−fall−run	American River, from the Jibboom Street bridge to the mouth.	July 16 to Dec. 16.
2015	fall−run	Feather River, from the unimproved boat ramp above the Thermalito Afterbay Outfall to 200 yards above the Live Oak boat ramp.	July 16 to Oct. 15.
2015	fall− and/or late−fall−run	Feather River, from 200 yards above Live Oak boat ramp to the mouth.	July 16 to Dec. 16.
2015	fall−run	Mokelumne River, From Camanche Dam to Highway 99 bridge.	July 16 to Oct. 15.
2015	fall− and/or late−fall−run	Mokelumne River, From the Highway 99 bridge to the Woodbridge Irrigation District Dam including Lodi Lake.	July 16 through Dec. 31.
2015	fall− and/or late−fall−run	Mokelumne River, From the Lower Sacramento Road bridge to the mouth.	July 16 through Dec. 16.
2015	fall− and/or late−fall−run	Upper Sacramento River, Deschutes Road Bridge to 500 feet upstream from Red Bluff Diversion Dam.	Aug. 1 to Dec. 16.
2015	fall− and/or late−fall−run	Middle Sacramento River, 150 feet below the Lower Red Bluff Boat Ramp to Hwy 113 Bridge (Knights Landing).	July 16 to Dec. 16.
2015	fall− and/or late−fall−run	Lower Sacramento River, from the Hwy 113 bridge near Knights Landing to the Carquinez Bridge.	July 16 to Dec. 16.

In 2015, the ocean harvest of Chinook Salmon off the California coastline was similar to years prior to 2008, and inland river harvest of adult Fall- and/or Late-fall-run Chinook Salmon was authorized on portions of the American, Feather, Mokelumne, and Sacramento Rivers.

2016 Angler Harvest Restrictions ↕

Year	Targeted salmon run	Watershed	Dates open to salmon harvest
2016	fall− and/or late−fall−run	American River, from Nimbus Dam to the Hazel Avenue bridge piers.	July 16 to Dec. 31.
2016	fall−run	American River, from Hazel Avenue bridge piers to the U.S. Geological Survey gauging station cable crossing about 300 yards downstream from the Nimbus Hatchery fish rack site.	July 16 to August 15
2016	fall−run	American River, from the U.S. Geological Survey gauging station cable crossing about 300 yards downstream from the Nimbus Hatchery fish rack site to the SMUD power line crossing at the southwest boundary of Ancil Hoffman Park.	July 16 to Oct. 31.
2016	fall− and/or late−fall−run	American River, from the SMUD power line crossing at the southwest boundary of Ancil Hoffman Park downstream to the Jibboom Street bridge.	July 16 to Dec. 31.
2016	fall− and/or late−fall−run	American River, from the Jibboom Street bridge to the mouth.	July 16 to Dec. 16.
2016	fall−run	Feather River, from the unimproved boat ramp above the Thermalito Afterbay Outfall to 200 yards above the Live Oak boat ramp.	July 16 to Oct. 15.
2016	fall− and/or late−fall−run	Feather River, from 200 yards above Live Oak boat ramp to the mouth.	July 16 to Dec. 16.
2016	fall−run	Mokelumne River, From Camanche Dam to Highway 99 bridge.	July 16 to Oct. 15.
2016	fall− and/or late−fall−run	Mokelumne River, From the Highway 99 bridge to the Woodbridge Irrigation District Dam including Lodi Lake.	July 16 through Dec. 31.
2016	fall− and/or late−fall−run	Mokelumne River, From the Lower Sacramento Road bridge to the mouth.	July 16 through Dec. 16.
2016	fall− and/or late−fall−run	Upper Sacramento River, Deschutes Road Bridge to 500 feet upstream from Red Bluff Diversion Dam.	Aug. 1 to Dec. 16.
2016	fall− and/or late−fall−run	Middle Sacramento River, 150 feet below the Lower Red Bluff Boat Ramp to Hwy 113 Bridge (Knights Landing).	July 16 to Dec. 16.
2016	fall− and/or late−fall−run	Lower Sacramento River, from the Hwy 113 bridge near Knights Landing to the Carquinez Bridge.	July 16 to Dec. 16.

In 2016, the ocean harvest of Chinook Salmon off the California coastline was similar to years prior to 2008, and inland river harvest of adult Fall- and/or Late-fall-run Chinook Salmon was authorized on portions of the American, Feather, Mokelumne, and Sacramento Rivers.

5.4 Appendix D: Annual Chinook Salmon Production Tables

1992 Total Adult Chinook Salmon Production = 227,525

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	5,911	6,456	5,565	28,099	46,031	60	27,618
Antelope Creek	0	0	0	0	0	80	0
Battle Creek	5,433	7,275	1,271	21,897	35,876	10	3,588
Bear River	NA	NA	NA	NA	NA	100	0
Big Chico Creek	NA	NA	NA	NA	NA	100	0
Butte Creek	NA	NA	NA	NA	NA	80	0
Clear Creek	600	0	60	1,037	1,697	80	1,358
Cosumnes River	NA	NA	NA	NA	NA	100	0
Cottonwood Creek	1,585	0	158	2,724	4,468	80	3,574
Cow Creek	NA	NA	NA	NA	NA	80	0
Deer Creek	NA	NA	NA	NA	NA	80	0
Feather River	24,105	16,440	8,109	76,224	124,878	60	74,927
Merced River	618	368	49	1,627	2,662	90	2,396
Mill Creek	999	0	100	1,728	2,827	80	2,262
Miscellaneous Creeks	NA	NA	NA	NA	NA	80	0
Mokelumne River	935	710	164	2,826	4,636	60	2,781
Paynes Creek	NA	NA	NA	NA	NA	80	0
Sacramento River	32,229	0	3,223	55,547	90,998	60	54,599
Stanislaus River	255	0	13	427	695	100	695
Tuolumne River	132	0	7	224	362	100	362
Yuba River	6,362	0	636	10,959	17,957	100	17,957
Total	79,164	31,249	19,356	203,318	333,087	NA	192,117

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	NA	344	69	648	1,060	10	106
Sacramento River	9,389	398	1,957	18,399	30,144	92	27,672
Total	9,389	742	2,026	19,047	31,204	NA	27,778

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	NA	NA	NA	NA	NA	NA	0
Sacramento River	1,203	34	0	1,930	3,167	100	3,167
Total	1,203	34	0	1,930	3,167	100	3,167

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	730	0	73	1,258	2,061	100	2,061
Deer Creek	209	0	21	360	590	100	590
Mill Creek	237	0	24	408	669	100	669
Sacramento River	371	0	74	697	1,143	100	1,143
Total	1,547	0	192	2,724	4,463	NA	4,463

1993 Total Adult Chinook Salmon Production = 324,546

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	31,027	10,656	18,757	106,273	166,713	60	100,028
Antelope Creek	NA	NA	NA	NA	NA	80	0
Battle Creek	11,029	7,587	1,862	36,001	56,478	10	5,648
Bear River	NA	NA	NA	NA	NA	100	0
Big Chico Creek	NA	NA	NA	NA	NA	100	0
Butte Creek	NA	NA	NA	NA	NA	80	0
Clear Creek	1,246	0	125	2,400	3,771	80	3,017
Cosumnes River	NA	NA	NA	NA	NA	100	0
Cottonwood Creek	NA	NA	NA	NA	NA	80	0
Cow Creek	NA	NA	NA	NA	NA	80	0
Deer Creek	72	0	7	141	220	80	176
Feather River	30,923	11,991	8,583	90,566	142,063	60	85,238
Merced River	1,269	409	84	3,106	4,868	90	4,381
Mill Creek	1,975	0	198	3,812	5,984	80	4,787
Miscellaneous Creeks	NA	NA	NA	NA	NA	80	0
Mokelumne River	993	2,164	316	6,106	9,579	60	5,747
Paynes Creek	NA	NA	NA	NA	NA	80	0
Sacramento River	46,231	0	4,623	89,437	140,291	60	84,175
Stanislaus River	677	0	34	1,235	1,946	100	1,946
Tuolumne River	471	0	24	882	1,377	100	1,377
Yuba River	6,703	0	670	12,953	20,326	100	20,326
Total	132,616	32,807	35,281	352,913	553,617	NA	316,846

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	NA	528	106	1,107	1,741	10	174
Sacramento River	339	400	148	1,550	2,436	92	2,237
Total	339	928	253	2,656	4,177	NA	2,411

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	NA	NA	NA	NA	NA	NA	0
Sacramento River	378	0	0	682	1,060	100	1,060
Total	378	0	0	682	1,060	100	1,060

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	650	0	65	1,253	1,968	100	1,968
Deer Creek	259	0	26	499	784	100	784
Mill Creek	61	0	6	118	185	100	185
Sacramento River	391	0	78	822	1,291	100	1,291
Total	1,361	0	175	2,692	4,229	NA	4,229

1994 Total Adult Chinook Salmon Production = 392,030

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	33,598	8,567	18,974	104,552	165,691	60	99,415
Antelope Creek	NA	NA	NA	NA	NA	80	0
Battle Creek	24,274	18,991	4,326	81,378	128,969	10	12,897
Bear River	NA	NA	NA	NA	NA	100	0
Big Chico Creek	NA	NA	NA	NA	NA	100	0
Butte Creek	NA	NA	NA	NA	NA	80	0
Clear Creek	2,546	0	255	4,805	7,606	80	6,085
Cosumnes River	NA	NA	NA	NA	NA	100	0
Cottonwood Creek	NA	NA	NA	NA	NA	80	0
Cow Creek	NA	NA	NA	NA	NA	80	0
Deer Creek	307	0	31	584	922	80	737
Feather River	38,382	15,202	10,717	109,986	174,287	60	104,572
Merced River	2,646	943	179	6,467	10,236	90	9,212
Mill Creek	1,081	0	108	2,021	3,210	80	2,568
Miscellaneous Creeks	NA	NA	NA	NA	NA	80	0
Mokelumne River	1,238	1,919	316	5,928	9,401	60	5,641
Paynes Creek	NA	NA	NA	NA	NA	80	0
Sacramento River	58,546	0	5,855	110,121	174,521	60	104,713
Stanislaus River	1,031	0	52	1,841	2,924	100	2,924
Tuolumne River	506	0	25	898	1,430	100	1,430
Yuba River	10,890	0	1,089	20,479	32,458	100	32,458
Total	175,045	45,622	41,927	449,060	711,654	NA	382,650

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	NA	598	120	1,227	1,945	10	195
Sacramento River	137	154	58	597	946	92	869
Total	137	752	178	1,825	2,892	NA	1,063

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	NA	NA	NA	NA	NA	NA	0
Sacramento River	144	42	0	319	505	100	505
Total	144	42	0	319	505	100	505

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	474	0	47	891	1,412	100	1,412
Deer Creek	485	0	48	911	1,444	100	1,444
Mill Creek	723	0	72	1,358	2,154	100	2,154
Sacramento River	862	0	172	1,767	2,801	100	2,801
Total	2,544	0	341	4,927	7,811	NA	7,811

1995 Total Adult Chinook Salmon Production = 751,231

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	70,618	6,498	34,702	279,893	391,712	60	235,027
Antelope Creek	NA	NA	NA	NA	NA	80	0
Battle Creek	56,515	26,677	8,319	229,085	320,596	10	32,060
Bear River	NA	NA	NA	NA	NA	100	0
Big Chico Creek	NA	NA	NA	NA	NA	100	0
Butte Creek	445	0	44	1,193	1,683	80	1,346
Clear Creek	9,298	0	930	25,653	35,881	80	28,704
Cosumnes River	NA	NA	NA	NA	NA	100	0
Cottonwood Creek	NA	NA	NA	NA	NA	80	0
Cow Creek	NA	NA	NA	NA	NA	80	0
Deer Creek	NA	NA	NA	NA	NA	80	0
Feather River	59,912	12,149	14,412	216,458	302,931	60	181,758
Merced River	2,320	602	146	7,656	10,724	90	9,652
Mill Creek	NA	NA	NA	NA	NA	80	0
Miscellaneous Creeks	NA	NA	NA	NA	NA	80	0
Mokelumne River	2,194	3,323	552	15,213	21,281	60	12,769
Paynes Creek	NA	NA	NA	NA	NA	80	0
Sacramento River	63,934	0	6,393	176,089	246,417	60	147,850
Stanislaus River	619	0	31	1,591	2,241	100	2,241
Tuolumne River	827	0	41	2,187	3,056	100	3,056
Yuba River	14,237	0	1,424	39,175	54,836	100	54,836
Total	280,919	49,249	66,995	994,194	1,391,357	NA	709,299

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	NA	323	65	948	1,336	10	134
Sacramento River	NA	166	33	487	686	92	630
Total	0	489	98	1,435	2,022	NA	764

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	NA	NA	NA	NA	NA	NA	0
Sacramento River	1,166	43	0	3,075	4,284	100	4,284
Total	1,166	43	0	3,075	4,284	100	4,284

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	7,500	0	750	20,627	28,877	100	28,877
Deer Creek	1,295	0	130	3,562	4,987	100	4,987
Mill Creek	320	0	32	880	1,232	100	1,232
Sacramento River	426	0	85	1,278	1,789	100	1,789
Total	9,541	0	997	26,346	36,884	NA	36,884

1996 Total Adult Chinook Salmon Production = 494,081

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	69,745	7,651	34,828	126,117	238,341	60	143,005
Antelope Creek	NA	NA	NA	NA	NA	80	0
Battle Creek	52,409	21,178	7,359	90,966	171,912	10	17,191
Bear River	NA	NA	NA	NA	NA	100	0
Big Chico Creek	NA	NA	NA	NA	NA	100	0
Butte Creek	500	0	50	613	1,163	80	931
Clear Creek	5,922	0	592	7,313	13,827	80	11,062
Cosumnes River	NA	NA	NA	NA	NA	100	0
Cottonwood Creek	NA	NA	NA	NA	NA	80	0
Cow Creek	NA	NA	NA	NA	NA	80	0
Deer Creek	NA	NA	NA	NA	NA	80	0
Feather River	57,170	8,107	13,055	88,041	166,374	60	99,824
Merced River	3,291	1,141	222	5,237	9,891	90	8,902
Mill Creek	NA	NA	NA	NA	NA	80	0
Miscellaneous Creeks	NA	NA	NA	NA	NA	80	0
Mokelumne River	4,038	3,883	792	9,814	18,527	60	11,116
Paynes Creek	NA	NA	NA	NA	NA	80	0
Sacramento River	84,086	0	8,409	103,941	196,436	60	117,862
Stanislaus River	168	0	8	189	365	100	365
Tuolumne River	4,362	0	218	5,143	9,723	100	9,723
Yuba River	27,900	0	2,790	34,490	65,180	100	65,180
Total	309,591	41,960	68,323	471,865	891,739	NA	485,160

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	NA	1,337	267	1,800	3,404	10	340
Sacramento River	NA	48	10	65	122	92	112
Total	0	1,385	277	1,865	3,527	NA	453

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	NA	NA	NA	NA	NA	NA	0
Sacramento River	1,012	0	0	1,148	2,160	100	2,160
Total	1,012	0	0	1,148	2,160	100	2,160

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	1,413	0	141	1,756	3,311	100	3,311
Deer Creek	614	0	61	763	1,439	100	1,439
Mill Creek	253	0	25	315	593	100	593
Sacramento River	378	0	76	513	966	100	966
Total	2,658	0	304	3,347	6,309	NA	6,309

1997 Total Adult Chinook Salmon Production = 608,297

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	47,195	5,650	23,780	111,370	187,995	60	112,797
Antelope Creek	NA	NA	NA	NA	NA	80	0
Battle Creek	50,744	50,670	10,141	162,097	273,652	10	27,365
Bear River	NA	NA	NA	NA	NA	100	0
Big Chico Creek	NA	NA	NA	NA	NA	100	0
Butte Creek	800	0	80	1,290	2,170	80	1,736
Clear Creek	8,569	0	857	13,717	23,143	80	18,515
Cosumnes River	NA	NA	NA	NA	NA	100	0
Cottonwood Creek	NA	NA	NA	NA	NA	80	0
Cow Creek	NA	NA	NA	NA	NA	80	0
Deer Creek	1,203	0	120	1,901	3,225	80	2,580
Feather River	50,547	15,128	13,135	114,493	193,303	60	115,982
Merced River	2,714	946	183	5,568	9,411	90	8,470
Mill Creek	478	0	48	747	1,273	80	1,018
Miscellaneous Creeks	NA	NA	NA	NA	NA	80	0
Mokelumne River	3,681	6,494	1,018	16,298	27,490	60	16,494
Paynes Creek	NA	NA	NA	NA	NA	80	0
Sacramento River	119,296	0	11,930	190,686	321,912	60	193,147
Stanislaus River	5,588	0	279	8,556	14,424	100	14,424
Tuolumne River	7,146	0	357	10,933	18,437	100	18,437
Yuba River	25,948	0	2,595	41,492	70,035	100	70,035
Total	323,909	78,888	64,523	679,151	1,146,471	NA	601,000

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	NA	4,578	916	8,011	13,505	10	1,350
Sacramento River	NA	NA	NA	NA	NA	NA	0
Total	0	4,578	916	8,011	13,505	NA	1,350

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	NA	NA	NA	NA	NA	NA	0
Sacramento River	836	0	0	1,243	2,079	100	2,079
Total	836	0	0	1,243	2,079	100	2,079

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	635	0	64	1,003	1,702	100	1,702
Deer Creek	466	0	47	736	1,249	100	1,249
Mill Creek	202	0	20	319	541	100	541
Sacramento River	128	0	26	221	374	100	374
Total	1,431	0	156	2,279	3,866	NA	3,866

1998 Total Adult Chinook Salmon Production = 410,720

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	50,457	11,788	28,010	81,176	171,431	60	102,859
Antelope Creek	NA	NA	NA	NA	NA	80	0
Battle Creek	53,957	44,351	9,831	97,253	205,392	10	20,539
Bear River	NA	NA	NA	NA	NA	100	0
Big Chico Creek	NA	NA	NA	NA	NA	100	0
Butte Creek	500	0	50	502	1,052	80	841
Clear Creek	4,259	0	426	4,224	8,909	80	7,127
Cosumnes River	300	0	30	290	620	100	620
Cottonwood Creek	NA	NA	NA	NA	NA	80	0
Cow Creek	NA	NA	NA	NA	NA	80	0
Deer Creek	270	0	27	264	561	80	449
Feather River	NA	18,889	3,778	20,380	43,047	60	25,828
Merced River	3,292	799	205	3,854	8,150	90	7,335
Mill Creek	546	0	55	528	1,129	80	903
Miscellaneous Creeks	NA	NA	NA	NA	NA	80	0
Mokelumne River	4,122	3,091	721	7,128	15,062	60	9,037
Paynes Creek	NA	NA	NA	NA	NA	80	0
Sacramento River	6,318	0	632	6,256	13,206	60	7,924
Stanislaus River	3,087	0	154	2,904	6,145	100	6,145
Tuolumne River	8,910	0	446	8,421	17,777	100	17,777
Yuba River	31,090	0	3,109	30,755	64,954	100	64,954
Total	167,108	78,918	47,473	263,935	557,433	NA	272,337

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	NA	3,079	616	3,325	7,020	10	702
Sacramento River	39,340	0	7,868	42,471	89,679	92	82,325
Total	39,340	3,079	8,484	45,795	96,698	NA	83,027

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	NA	NA	NA	NA	NA	NA	0
Sacramento River	2,893	99	0	2,688	5,680	100	5,680
Total	2,893	99	0	2,688	5,680	100	5,680

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	20,259	0	2,026	20,038	42,323	100	42,323
Deer Creek	1,879	0	188	1,858	3,925	100	3,925
Mill Creek	424	0	42	419	885	100	885
Sacramento River	1,115	0	223	1,204	2,542	100	2,542
Total	23,677	0	2,479	23,519	49,676	NA	49,676

1999 Total Adult Chinook Salmon Production = 433,886

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	55,339	9,760	29,295	62,462	156,855	60	94,113
Antelope Creek	NA	NA	NA	NA	NA	80	0
Battle Creek	92,929	26,970	11,990	87,276	219,164	10	21,916
Bear River	NA	NA	NA	NA	NA	100	0
Big Chico Creek	NA	NA	NA	NA	NA	100	0
Butte Creek	NA	NA	NA	NA	NA	80	0
Clear Creek	8,003	0	800	5,831	14,634	80	11,707
Cosumnes River	229	0	23	158	410	100	410
Cottonwood Creek	NA	NA	NA	NA	NA	80	0
Cow Creek	NA	NA	NA	NA	NA	80	0
Deer Creek	NA	NA	NA	NA	NA	80	0
Feather River	NA	12,927	2,585	10,268	25,780	60	15,468
Merced River	3,129	1,637	238	3,296	8,300	90	7,470
Mill Creek	NA	NA	NA	NA	NA	80	0
Miscellaneous Creeks	NA	NA	NA	NA	NA	80	0
Mokelumne River	2,183	3,150	533	3,866	9,733	60	5,840
Paynes Creek	NA	NA	NA	NA	NA	80	0
Sacramento River	161,192	0	16,119	117,350	294,661	60	176,797
Stanislaus River	4,349	0	217	3,011	7,577	100	7,577
Tuolumne River	8,232	0	412	5,704	14,348	100	14,348
Yuba River	24,230	0	2,423	17,652	44,305	100	44,305
Total	359,815	54,444	64,636	316,873	795,768	NA	399,951

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	NA	7,075	1,415	5,613	14,103	10	1,410
Sacramento River	8,683	0	1,737	6,888	17,308	92	15,889
Total	8,683	7,075	3,152	12,501	31,411	NA	17,299

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	NA	NA	NA	NA	NA	NA	0
Sacramento River	3,264	24	0	2,184	5,472	100	5,472
Total	3,264	24	0	2,184	5,472	100	5,472

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	3,679	0	368	2,669	6,716	100	6,716
Deer Creek	1,591	0	159	1,154	2,904	100	2,904
Mill Creek	560	0	56	406	1,022	100	1,022
Sacramento River	262	0	52	207	522	100	522
Total	6,092	0	635	4,436	11,163	NA	11,163

2000 Total Adult Chinook Salmon Production = 692,921

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	100,852	11,160	50,405	158,781	321,198	60	192,719
Antelope Creek	NA	NA	NA	NA	NA	80	0
Battle Creek	53,447	21,659	7,511	80,791	163,408	10	16,341
Bear River	NA	NA	NA	NA	NA	100	0
Big Chico Creek	NA	NA	NA	NA	NA	100	0
Butte Creek	NA	NA	NA	NA	NA	80	0
Clear Creek	6,687	0	669	7,204	14,560	80	11,648
Cosumnes River	460	0	46	515	1,021	100	1,021
Cottonwood Creek	NA	NA	NA	NA	NA	80	0
Cow Creek	NA	NA	NA	NA	NA	80	0
Deer Creek	NA	NA	NA	NA	NA	80	0
Feather River	114,717	18,146	26,573	155,865	315,301	60	189,180
Merced River	11,130	1,946	654	13,437	27,166	90	24,450
Mill Creek	NA	NA	NA	NA	NA	80	0
Miscellaneous Creeks	NA	NA	NA	NA	NA	80	0
Mokelumne River	1,973	5,450	742	8,005	16,170	60	9,702
Paynes Creek	NA	NA	NA	NA	NA	80	0
Sacramento River	96,688	0	9,669	104,005	210,362	60	126,217
Stanislaus River	8,498	0	425	8,748	17,671	100	17,671
Tuolumne River	17,873	0	894	18,354	37,121	100	37,121
Yuba River	14,995	0	1,500	16,124	32,618	100	32,618
Total	427,320	58,361	99,086	571,829	1,156,596	NA	658,688

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	0	4,181	836	4,896	9,913	10	991
Sacramento River	8,702	0	1,740	10,191	20,634	92	18,942
Total	8,702	4,181	2,577	15,087	30,547	NA	19,933

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	NA	NA	NA	NA	NA	NA	0
Sacramento River	1,261	89	0	1,307	2,657	100	2,657
Total	1,261	89	0	1,307	2,657	100	2,657

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	4,118	0	412	4,438	8,968	100	8,968
Deer Creek	637	0	64	687	1,387	100	1,387
Mill Creek	544	0	54	587	1,185	100	1,185
Sacramento River	43	0	9	51	102	100	102
Total	5,342	0	538	5,762	11,643	NA	11,643

2001 Total Adult Chinook Salmon Production = 583,510

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	135,384	11,750	66,210	61,508	274,853	60	164,912
Antelope Creek	NA	NA	NA	NA	NA	80	0
Battle Creek	100,604	24,698	12,530	39,731	177,564	10	17,756
Bear River	NA	NA	NA	NA	NA	100	0
Big Chico Creek	NA	NA	NA	NA	NA	100	0
Butte Creek	4,433	0	443	1,398	6,274	80	5,019
Clear Creek	10,865	0	1,086	3,451	15,403	80	12,322
Cosumnes River	NA	NA	NA	NA	NA	100	0
Cottonwood Creek	NA	NA	NA	NA	NA	80	0
Cow Creek	NA	NA	NA	NA	NA	80	0
Deer Creek	NA	NA	NA	NA	NA	80	0
Feather River	178,645	24,870	40,703	70,420	314,638	60	188,783
Merced River	9,181	1,663	542	3,276	14,663	90	13,196
Mill Creek	NA	NA	NA	NA	NA	80	0
Miscellaneous Creeks	NA	NA	NA	NA	NA	80	0
Mokelumne River	2,307	5,728	804	2,556	11,394	60	6,836
Paynes Creek	NA	NA	NA	NA	NA	80	0
Sacramento River	75,296	0	7,530	23,874	106,699	60	64,020
Stanislaus River	7,033	0	352	2,119	9,503	100	9,503
Tuolumne River	8,782	0	439	2,665	11,886	100	11,886
Yuba River	23,392	0	2,339	7,426	33,158	100	33,158
Total	555,922	68,709	132,979	218,424	976,034	NA	527,391

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	98	2,439	507	879	3,923	10	392
Sacramento River	19,276	0	3,855	6,676	29,808	92	27,363
Total	19,374	2,439	4,363	7,555	33,731	NA	27,756

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	NA	NA	NA	NA	NA	NA	0
Sacramento River	8,120	104	0	2,371	10,595	94	9,938
Total	8,120	104	0	2,371	10,595	NA	9,938

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	9,605	0	960	3,038	13,604	100	13,604
Deer Creek	1,622	0	162	513	2,297	100	2,297
Mill Creek	1,104	0	110	349	1,564	100	1,564
Sacramento River	621	0	124	214	960	100	960
Total	12,952	0	1,357	4,115	18,424	NA	18,424

2002 Total Adult Chinook Salmon Production = 624,822

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	124,252	9,817	60,331	79,946	274,346	60	164,608
Antelope Creek	NA	NA	NA	NA	NA	80	0
Battle Creek	397,149	65,924	46,307	209,518	718,898	10	71,890
Bear River	NA	NA	NA	NA	NA	100	0
Big Chico Creek	NA	NA	NA	NA	NA	100	0
Butte Creek	3,665	0	366	1,675	5,707	80	4,565
Clear Creek	16,071	0	1,607	7,287	24,965	80	19,972
Cosumnes River	1,350	0	135	628	2,113	100	2,113
Cottonwood Creek	NA	NA	NA	NA	NA	80	0
Cow Creek	NA	NA	NA	NA	NA	80	0
Deer Creek	NA	NA	NA	NA	NA	80	0
Feather River	105,163	20,507	25,134	62,022	212,826	60	127,696
Merced River	8,866	1,840	535	4,607	15,848	90	14,263
Mill Creek	2,611	0	261	1,173	4,045	80	3,236
Miscellaneous Creeks	NA	NA	NA	NA	NA	80	0
Mokelumne River	2,840	7,913	1,075	4,858	16,686	60	10,012
Paynes Creek	NA	NA	NA	NA	NA	80	0
Sacramento River	65,690	0	6,569	29,734	101,993	60	61,196
Stanislaus River	7,787	0	389	3,350	11,527	100	11,527
Tuolumne River	7,173	0	359	3,099	10,631	100	10,631
Yuba River	24,051	0	2,405	10,888	37,345	100	37,345
Total	766,668	106,001	145,475	418,785	1,436,928	NA	539,052

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	216	4,186	880	2,174	7,456	10	746
Sacramento River	36,004	0	7,201	17,788	60,992	92	55,991
Total	36,220	4,186	8,081	19,961	68,449	NA	56,737

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	NA	NA	NA	NA	NA	NA	0
Sacramento River	7,337	104	0	3,043	10,484	88	9,195
Total	7,337	104	0	3,043	10,484	NA	9,195

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	8,785	0	878	3,966	13,630	100	13,630
Deer Creek	2,195	0	220	991	3,406	100	3,406
Mill Creek	1,594	0	159	720	2,473	100	2,473
Sacramento River	195	0	39	96	330	100	330
Total	12,769	0	1,296	5,774	19,839	NA	19,839

2003 Total Adult Chinook Salmon Production = 555,033

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	163,742	14,887	80,383	106,525	365,537	60	219,322
Antelope Creek	NA	NA	NA	NA	NA	80	0
Battle Creek	64,764	88,234	15,300	69,204	237,502	10	23,750
Bear River	NA	NA	NA	NA	NA	100	0
Big Chico Creek	NA	NA	NA	NA	NA	100	0
Butte Creek	3,492	0	349	1,575	5,416	80	4,333
Clear Creek	9,475	0	948	4,279	14,701	80	11,761
Cosumnes River	122	0	12	59	194	100	194
Cottonwood Creek	NA	NA	NA	NA	NA	80	0
Cow Creek	NA	NA	NA	NA	NA	80	0
Deer Creek	NA	NA	NA	NA	NA	80	0
Feather River	89,946	14,976	20,984	51,792	177,698	60	106,619
Merced River	2,530	549	154	1,337	4,570	90	4,113
Mill Creek	2,426	0	243	1,099	3,768	80	3,014
Miscellaneous Creeks	NA	NA	NA	NA	NA	80	0
Mokelumne River	2,122	8,117	1,024	4,635	15,898	60	9,539
Paynes Creek	NA	NA	NA	NA	NA	80	0
Sacramento River	89,229	0	8,923	40,352	138,504	60	83,102
Stanislaus River	5,902	0	295	2,555	8,753	100	8,753
Tuolumne River	2,163	0	108	921	3,192	100	3,192
Yuba River	28,316	0	2,832	12,807	43,954	100	43,954
Total	464,229	126,763	131,554	297,140	1,019,686	NA	521,646

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	57	3,183	648	1,597	5,485	10	548
Sacramento River	5,494	38	1,106	2,725	9,364	92	8,596
Total	5,551	3,221	1,754	4,322	14,848	NA	9,144

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	NA	NA	NA	NA	NA	NA	0
Sacramento River	8,133	85	0	3,365	11,583	94	10,911
Total	8,133	85	0	3,365	11,583	NA	10,911

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	4,398	0	440	1,993	6,831	100	6,831
Deer Creek	2,759	0	276	1,250	4,285	100	4,285
Mill Creek	1,426	0	143	646	2,215	100	2,215
Sacramento River	0	0	0	0	0	0	0
Total	8,583	0	858	3,889	13,331	NA	13,331

2004 Total Adult Chinook Salmon Production = 566,861

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	99,230	26,400	56,534	191,486	373,650	60	224,190
Antelope Creek	NA	NA	NA	NA	NA	80	0
Battle Creek	23,861	69,172	9,303	107,589	209,925	10	20,993
Bear River	NA	NA	NA	NA	NA	100	0
Big Chico Creek	NA	NA	NA	NA	NA	100	0
Butte Creek	2,516	0	252	2,905	5,673	80	4,538
Clear Creek	6,365	0	636	7,363	14,364	80	11,492
Cosumnes River	1,208	0	121	1,402	2,731	100	2,731
Cottonwood Creek	NA	NA	NA	NA	NA	80	0
Cow Creek	NA	NA	NA	NA	NA	80	0
Deer Creek	300	0	30	351	681	80	544
Feather River	54,171	21,297	15,094	95,167	185,729	60	111,437
Merced River	3,270	1,050	216	4,758	9,294	90	8,365
Mill Creek	1,192	0	119	1,402	2,714	80	2,171
Miscellaneous Creeks	NA	NA	NA	NA	NA	80	0
Mokelumne River	1,588	10,356	1,194	13,824	26,963	60	16,178
Paynes Creek	NA	NA	NA	NA	NA	80	0
Sacramento River	43,604	0	4,360	50,439	98,403	60	59,042
Stanislaus River	4,015	0	201	4,408	8,623	100	8,623
Tuolumne River	1,984	0	99	2,204	4,287	100	4,287
Yuba River	15,269	0	1,527	17,631	34,427	100	34,427
Total	258,573	128,275	89,686	500,929	977,463	NA	509,017

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	40	5,166	1,041	6,560	12,807	10	1,281
Sacramento River	8,824	60	1,777	11,194	21,855	92	20,063
Total	8,864	5,226	2,818	17,754	34,662	NA	21,343

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	NA	NA	NA	NA	NA	NA	0
Sacramento River	7,784	85	0	8,285	16,154	92	14,862
Total	7,784	85	0	8,285	16,154	100	14,862

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	7,390	0	739	8,535	16,664	100	16,664
Deer Creek	804	0	80	929	1,813	100	1,813
Mill Creek	998	0	100	1,153	2,250	100	2,250
Sacramento River	370	0	74	467	911	100	911
Total	9,562	0	993	11,083	21,638	NA	21,638

2005 Total Adult Chinook Salmon Production = 466,203

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	62,679	22,349	38,263	84,823	208,114	60	124,868
Antelope Creek	NA	NA	NA	NA	NA	80	0
Battle Creek	20,520	142,673	16,319	123,509	303,021	10	30,302
Bear River	NA	NA	NA	NA	NA	100	0
Big Chico Creek	NA	NA	NA	NA	NA	100	0
Butte Creek	4,255	0	426	3,209	7,889	80	6,312
Clear Creek	14,824	0	1,482	11,231	27,538	80	22,030
Cosumnes River	370	0	37	285	692	100	692
Cottonwood Creek	NA	NA	NA	NA	NA	80	0
Cow Creek	NA	NA	NA	NA	NA	80	0
Deer Creek	963	0	96	713	1,772	80	1,418
Feather River	49,160	22,405	14,313	59,080	144,958	60	86,975
Merced River	1,942	421	118	1,711	4,193	90	3,773
Mill Creek	2,426	0	243	1,854	4,523	80	3,618
Miscellaneous Creeks	NA	NA	NA	NA	NA	80	0
Mokelumne River	10,406	5,563	1,597	12,087	29,653	60	17,792
Paynes Creek	NA	NA	NA	NA	NA	80	0
Sacramento River	57,012	0	5,701	43,143	105,856	60	63,513
Stanislaus River	1,427	0	71	1,034	2,532	100	2,532
Tuolumne River	668	0	33	499	1,201	100	1,201
Yuba River	17,630	0	1,763	13,335	32,728	100	32,728
Total	244,282	193,411	80,463	356,514	874,670	NA	397,755

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	23	5,562	1,117	4,605	11,307	10	1,131
Sacramento River	10,524	79	2,121	8,744	21,467	92	19,707
Total	10,547	5,641	3,238	13,349	32,775	NA	20,838

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	NA	NA	NA	NA	NA	NA	0
Sacramento River	15,730	109	0	10,883	26,722	80	21,511
Total	15,730	109	0	10,883	26,722	100	21,511

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	10,625	0	1,062	8,054	19,742	100	19,742
Deer Creek	2,239	0	224	1,697	4,160	100	4,160
Mill Creek	1,150	0	115	872	2,137	100	2,137
Sacramento River	30	0	6	24	60	100	60
Total	14,044	0	1,407	10,648	26,099	NA	26,099

2006 Total Adult Chinook Salmon Production = 274,956

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	24,540	8,728	14,971	15,554	63,793	60	38,276
Antelope Creek	NA	NA	NA	NA	NA	80	0
Battle Creek	19,493	57,832	7,732	27,439	112,496	10	11,250
Bear River	NA	NA	NA	NA	NA	100	0
Big Chico Creek	NA	NA	NA	NA	NA	100	0
Butte Creek	1,920	0	192	685	2,797	80	2,238
Clear Creek	8,422	0	842	2,985	12,249	80	9,799
Cosumnes River	530	0	53	188	771	100	771
Cottonwood Creek	NA	NA	NA	NA	NA	80	0
Cow Creek	4,209	0	421	1,492	6,122	80	4,898
Deer Creek	1,905	0	190	674	2,770	80	2,216
Feather River	76,414	14,034	18,090	35,011	143,549	60	86,129
Merced River	1,429	150	79	531	2,189	90	1,970
Mill Creek	1,403	0	140	497	2,041	80	1,633
Miscellaneous Creeks	NA	NA	NA	NA	NA	80	0
Mokelumne River	1,732	4,139	587	2,078	8,536	60	5,122
Paynes Creek	NA	NA	NA	NA	NA	80	0
Sacramento River	55,468	0	5,547	19,678	80,693	60	48,416
Stanislaus River	1,923	0	96	652	2,671	100	2,671
Tuolumne River	562	0	28	188	778	100	778
Yuba River	8,121	0	812	2,885	11,818	100	11,818
Total	208,071	84,883	49,781	110,540	453,274	NA	227,985

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	50	4,822	974	1,887	7,733	10	773
Sacramento River	10,163	12	2,035	3,941	16,151	92	14,826
Total	10,213	4,834	3,009	5,828	23,884	NA	15,600

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	NA	NA	NA	NA	NA	NA	0
Sacramento River	17,197	93	0	5,578	22,868	86	19,712
Total	17,197	93	0	5,578	22,868	NA	19,712

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	4,579	0	458	1,626	6,663	100	6,663
Deer Creek	2,432	0	243	864	3,539	100	3,539
Mill Creek	1,002	0	100	356	1,458	100	1,458
Sacramento River	0	0	0	0	0	0	0
Total	8,013	0	801	2,845	11,659	NA	11,659

2007 Total Adult Chinook Salmon Production = 155,042

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	10,120	4,597	6,623	16,270	37,610	60	22,566
Antelope Creek	NA	NA	NA	NA	NA	80	0
Battle Creek	9,904	11,744	2,165	18,160	41,973	10	4,197
Bear River	NA	NA	NA	NA	NA	100	0
Big Chico Creek	NA	NA	NA	NA	NA	100	0
Butte Creek	1,225	0	122	1,024	2,371	80	1,897
Clear Creek	4,157	0	416	3,483	8,056	80	6,445
Cosumnes River	77	0	8	61	146	100	146
Cottonwood Creek	1,250	0	125	1,050	2,425	80	1,940
Cow Creek	2,044	0	204	1,715	3,964	80	3,171
Deer Creek	563	0	56	473	1,092	80	874
Feather River	21,909	6,170	5,616	25,696	59,391	60	35,634
Merced River	485	79	28	455	1,047	90	943
Mill Creek	851	0	85	718	1,654	80	1,323
Miscellaneous Creeks	140	0	14	114	268	80	214
Mokelumne River	470	1,051	152	1,278	2,951	60	1,771
Paynes Creek	NA	NA	NA	NA	NA	80	0
Sacramento River	17,061	0	1,706	14,309	33,077	60	19,846
Stanislaus River	443	0	22	359	824	100	824
Tuolumne River	224	0	11	175	410	100	410
Yuba River	2,604	0	260	2,188	5,052	100	5,052
Total	73,527	23,641	17,614	87,528	202,311	NA	107,253

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	72	3,361	687	3,141	7,261	10	726
Sacramento River	15,275	66	3,068	14,033	32,442	92	29,782
Total	15,347	3,427	3,755	17,174	39,703	NA	30,508

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	0	0	0	0	0	NA	0
Sacramento River	2,487	54	0	1,932	4,473	93	4,142
Total	2,487	54	0	1,932	4,473	NA	4,142

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	4,943	0	494	4,145	9,582	100	9,582
Deer Creek	644	0	64	540	1,248	100	1,248
Mill Creek	920	0	92	771	1,783	100	1,783
Sacramento River	248	0	50	227	524	100	524
Total	6,755	0	700	5,683	13,138	NA	13,138

2008 Total Adult Chinook Salmon Production = 51,105

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	2,514	3,232	0	0	5,746	60	3,448
Antelope Creek	NA	NA	NA	NA	NA	NA	0
Battle Creek	4,286	10,639	0	0	14,925	10	1,492
Bear River	NA	NA	NA	NA	NA	NA	0
Big Chico Creek	NA	NA	NA	NA	NA	NA	0
Butte Creek	275	0	0	0	275	80	220
Clear Creek	7,677	0	0	0	7,677	80	6,142
Cosumnes River	15	0	0	0	15	100	15
Cottonwood Creek	510	0	0	0	510	80	408
Cow Creek	478	0	0	0	478	80	382
Deer Creek	194	0	0	0	194	80	155
Feather River	5,939	4,914	0	0	10,853	60	6,512
Merced River	389	76	0	0	465	90	418
Mill Creek	218	0	0	0	218	80	174
Miscellaneous Creeks	19	0	0	0	19	80	15
Mokelumne River	173	239	0	0	412	60	247
Paynes Creek	NA	NA	NA	NA	NA	NA	0
Sacramento River	24,743	0	0	0	24,743	60	14,846
Stanislaus River	865	0	0	0	865	100	865
Tuolumne River	388	0	0	0	388	100	388
Yuba River	3,508	0	0	0	3,508	100	3,508
Total	52,191	19,100	0	0	71,291	NA	39,236

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	19	6,334	0	0	6,353	10	635
Sacramento River	3,964	0	579	0	4,543	92	4,170
Total	3,983	6,334	579	0	10,896	NA	4,806

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	0	0	0	0	0	NA	0
Sacramento River	2,725	105	0	0	2,830	90	2,555
Total	2,725	105	0	0	2,830	NA	2,555

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	3,935	0	0	0	3,935	100	3,935
Deer Creek	140	0	0	0	140	100	140
Mill Creek	381	0	0	0	381	100	381
Sacramento River	52	0	0	0	52	100	52
Total	4,508	0	0	0	4,508	NA	4,508

2009 Total Adult Chinook Salmon Production = 41,381

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	5,297	4,789	0	0	10,086	60	6,052
Antelope Creek	NA	NA	NA	NA	NA	NA	0
Battle Creek	3,047	6,152	0	0	9,199	10	920
Bear River	NA	NA	NA	NA	NA	NA	0
Big Chico Creek	NA	NA	NA	NA	NA	NA	0
Butte Creek	306	0	0	0	306	80	245
Clear Creek	3,228	0	0	0	3,228	80	2,582
Cosumnes River	0	0	0	0	0	100	0
Cottonwood Creek	1,055	0	0	0	1,055	80	844
Cow Creek	261	0	0	0	261	80	209
Deer Creek	58	0	0	0	58	80	46
Feather River	4,847	9,963	0	0	14,810	60	8,886
Merced River	358	246	0	0	604	90	544
Mill Creek	102	0	0	0	102	80	82
Miscellaneous Creeks	6	0	0	0	6	80	5
Mokelumne River	680	1,553	0	0	2,233	60	1,340
Paynes Creek	NA	NA	NA	NA	NA	NA	0
Sacramento River	5,827	0	0	0	5,827	60	3,496
Stanislaus River	595	0	0	0	595	100	595
Tuolumne River	124	0	0	0	124	100	124
Yuba River	4,635	0	0	0	4,635	100	4,635
Total	30,426	22,703	0	0	53,129	NA	30,604

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	32	6,436	0	0	6,468	10	647
Sacramento River	3,334	58	495	0	3,887	92	3,568
Total	3,366	6,494	495	0	10,355	NA	4,215

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	0	0	0	0	0	NA	0
Sacramento River	4,416	121	0	0	4,537	90	4,070
Total	4,416	121	0	0	4,537	NA	4,070

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	2,059	0	0	0	2,059	100	2,059
Deer Creek	213	0	0	0	213	100	213
Mill Creek	220	0	0	0	220	100	220
Sacramento River	0	0	0	0	0	100	0
Total	2,492	0	0	0	2,492	NA	2,492

2010 Total Adult Chinook Salmon Production = 130,769

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	14,688	9,095	10,702	2,457	36,943	60	22,166
Antelope Creek	NA	NA	NA	NA	NA	NA	0
Battle Creek	6,631	17,237	2,387	1,871	28,126	10	2,813
Bear River	NA	NA	NA	NA	NA	NA	0
Big Chico Creek	NA	NA	NA	NA	NA	NA	0
Butte Creek	370	0	37	29	436	80	349
Clear Creek	7,192	0	719	563	8,474	80	6,779
Cosumnes River	740	0	74	58	872	100	872
Cottonwood Creek	1,137	0	114	89	1,339	80	1,071
Cow Creek	536	0	54	42	631	80	505
Deer Creek	166	0	17	12	195	80	156
Feather River	44,914	19,973	12,977	5,549	83,413	60	50,048
Merced River	651	146	40	59	896	90	807
Mill Creek	144	0	14	11	169	80	136
Miscellaneous Creeks	NA	NA	NA	NA	NA	80	0
Mokelumne River	1,920	5,275	720	565	8,479	60	5,087
Paynes Creek	NA	NA	NA	NA	NA	NA	0
Sacramento River	16,372	0	1,637	1,283	19,292	60	11,575
Stanislaus River	1,086	0	54	82	1,222	100	1,222
Tuolumne River	540	0	27	40	607	100	607
Yuba River	14,375	0	1,438	1,126	16,939	100	16,939
Total	111,462	51,726	31,010	13,836	208,034	NA	121,132

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	27	5,505	1,106	473	7,111	10	711
Sacramento River	4,282	81	873	373	5,609	92	5,149
Total	4,309	5,586	1,979	846	12,720	NA	5,860

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	0	0	0	0	0	NA	0
Sacramento River	1,533	63	0	114	1,710	90	1,534
Total	1,533	63	0	114	1,710	NA	1,534

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	1,160	0	116	91	1,367	100	1,367
Deer Creek	262	0	26	21	309	100	309
Mill Creek	482	0	48	38	568	100	568
Sacramento River	0	0	0	0	0	100	0
Total	1,904	0	190	149	2,244	NA	2,244

2011 Total Adult Chinook Salmon Production = 181,054

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	25,626	12,680	17,238	11,820	67,363	60	40,418
Antelope Creek	NA	NA	NA	NA	NA	NA	0
Battle Creek	12,513	42,092	5,460	12,785	72,850	10	7,285
Bear River	NA	NA	NA	NA	NA	NA	0
Big Chico Creek	NA	NA	NA	NA	NA	NA	0
Butte Creek	416	0	42	98	556	80	445
Clear Creek	4,841	0	484	1,133	6,458	80	5,166
Cosumnes River	53	0	5	12	70	100	70
Cottonwood Creek	2,144	0	214	503	2,861	80	2,289
Cow Creek	1,810	0	181	422	2,413	80	1,930
Deer Creek	662	0	66	156	884	80	707
Feather River	47,289	32,616	15,981	20,408	116,294	60	69,777
Merced River	1,571	371	97	433	2,473	90	2,225
Mill Creek	1,231	0	123	289	1,643	80	1,314
Miscellaneous Creeks	NA	NA	NA	NA	NA	80	0
Mokelumne River	2,674	15,922	1,860	4,352	24,808	60	14,885
Paynes Creek	NA	NA	NA	NA	NA	NA	0
Sacramento River	11,957	0	1,196	2,797	15,950	60	9,570
Stanislaus River	1,309	0	65	295	1,669	100	1,669
Tuolumne River	893	0	45	202	1,140	100	1,140
Yuba River	8,928	0	893	2,092	11,913	100	11,913
Total	123,917	103,681	43,950	57,798	329,346	NA	170,804

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	28	4,637	933	1,193	6,791	10	679
Sacramento River	3,686	39	745	952	5,422	92	4,978
Total	3,714	4,676	1,678	2,145	12,213	NA	5,657

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	0	0	0	0	0	NA	0
Sacramento River	738	88	0	176	1,002	90	899
Total	738	88	0	176	1,002	NA	899

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	2,130	0	213	500	2,843	100	2,843
Deer Creek	271	0	27	64	362	100	362
Mill Creek	366	0	37	86	489	100	489
Sacramento River	0	0	0	0	0	100	0
Total	2,767	0	277	650	3,694	NA	3,694

2012 Total Adult Chinook Salmon Production = 324,494

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	38,328	9,257	21,413	40,576	109,574	60	65,744
Antelope Creek	NA	NA	NA	NA	NA	NA	0
Battle Creek	31,554	84,289	11,584	74,960	202,387	10	20,239
Bear River	NA	NA	NA	NA	NA	NA	0
Big Chico Creek	NA	NA	NA	NA	NA	NA	0
Butte Creek	813	0	81	520	1,414	80	1,131
Clear Creek	7,631	0	763	4,939	13,333	80	10,667
Cosumnes River	1,071	0	107	685	1,863	100	1,863
Cottonwood Creek	2,556	0	256	1,654	4,466	80	3,573
Cow Creek	1,488	0	149	969	2,606	80	2,085
Deer Creek	873	0	87	567	1,527	80	1,222
Feather River	63,649	42,160	21,162	74,677	201,647	60	120,988
Merced River	2,011	1,000	151	1,867	5,028	90	4,526
Mill Creek	890	0	89	567	1,546	80	1,237
Miscellaneous Creeks	NA	NA	NA	NA	NA	80	0
Mokelumne River	5,471	6,620	1,209	7,822	21,122	60	12,673
Paynes Creek	NA	NA	NA	NA	NA	NA	0
Sacramento River	28,701	0	2,870	18,575	50,146	60	30,087
Stanislaus River	4,006	0	200	2,481	6,688	100	6,688
Tuolumne River	783	0	39	473	1,295	100	1,295
Yuba River	7,668	0	767	4,963	13,397	100	13,397
Total	197,493	143,326	60,928	236,294	638,041	NA	297,415

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	19	3,048	613	2,171	5,851	10	585
Sacramento River	2,822	47	574	2,031	5,474	92	5,025
Total	2,841	3,095	1,187	4,202	11,325	NA	5,610

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	NA	NA	NA	NA	NA	NA	0
Sacramento River	2,578	93	0	1,566	4,237	90	3,801
Total	2,578	93	0	1,566	4,237	NA	3,801

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	8,615	0	862	5,568	15,044	100	15,044
Deer Creek	734	0	73	475	1,282	100	1,282
Mill Creek	768	0	77	496	1,341	100	1,341
Sacramento River	0	0	0	0	0	100	0
Total	10,117	0	1,012	6,539	17,668	NA	17,668

2013 Total Adult Chinook Salmon Production = 437,307

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	58,228	9,076	30,287	42,069	139,660	60	83,796
Antelope Creek	NA	NA	NA	NA	NA	NA	0
Battle Creek	30,834	70,021	10,086	47,817	158,757	10	15,876
Bear River	NA	NA	NA	NA	NA	NA	0
Big Chico Creek	NA	NA	NA	NA	NA	NA	0
Butte Creek	2,200	0	220	1,034	3,454	80	2,764
Clear Creek	13,337	0	1,334	6,322	20,993	80	16,794
Cosumnes River	0	0	0	0	0	100	0
Cottonwood Creek	2,774	0	277	1,310	4,362	80	3,489
Cow Creek	3,011	0	301	1,425	4,737	80	3,790
Deer Creek	1,026	0	103	483	1,611	80	1,289
Feather River	151,209	27,622	35,766	92,484	307,081	60	184,249
Merced River	2,826	1,098	196	1,770	5,890	90	5,301
Mill Creek	2,197	0	220	1,034	3,451	80	2,761
Miscellaneous Creeks	NA	NA	NA	NA	NA	80	0
Mokelumne River	7,071	5,181	1,225	5,816	19,293	60	11,576
Paynes Creek	175	0	18	92	284	80	228
Sacramento River	40,084	0	4,008	19,012	63,104	60	37,862
Stanislaus River	2,845	0	142	1,287	4,275	100	4,275
Tuolumne River	1,926	0	96	874	2,896	100	2,896
Yuba River	14,880	0	1,488	7,058	23,426	100	23,426
Total	334,623	112,998	85,767	229,888	763,276	NA	400,371

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	42	3,615	731	1,893	6,282	10	628
Sacramento River	5,227	43	1,054	2,728	9,052	92	8,310
Total	5,269	3,658	1,785	4,621	15,334	NA	8,938

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	NA	NA	NA	NA	NA	NA	0
Sacramento River	5,920	164	0	2,627	8,711	90	7,814
Total	5,920	164	0	2,627	8,711	NA	7,814

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	11,470	0	1,147	5,440	18,057	100	18,057
Deer Creek	708	0	71	336	1,114	100	1,114
Mill Creek	644	0	64	305	1,014	100	1,014
Sacramento River	0	0	0	0	0	100	0
Total	12,822	0	1,282	6,080	20,185	NA	20,185

2014 Total Adult Chinook Salmon Production = 265,109

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	26,475	8,343	15,668	21,213	71,699	60	43,020
Antelope Creek	143	0	14	64	221	80	177
Battle Creek	27,064	19,277	4,634	21,429	72,404	10	7,240
Bear River	NA	NA	NA	NA	NA	NA	0
Big Chico Creek	NA	NA	NA	NA	NA	NA	0
Butte Creek	1,412	0	141	648	2,201	80	1,761
Clear Creek	15,794	0	1,579	7,304	24,677	80	19,742
Cosumnes River	373	0	37	178	588	100	588
Cottonwood Creek	1,940	0	194	902	3,036	80	2,429
Cow Creek	3,535	0	354	1,639	5,527	80	4,422
Deer Creek	849	0	85	394	1,328	80	1,062
Feather River	61,200	23,420	16,924	42,680	144,224	60	86,535
Merced River	922	811	87	762	2,582	90	2,324
Mill Creek	2,488	0	249	1,156	3,893	80	3,114
Miscellaneous Creeks	NA	NA	NA	NA	NA	80	0
Mokelumne River	3,297	8,816	1,211	5,602	18,926	60	11,356
Paynes Creek	72	0	7	38	117	80	94
Sacramento River	34,876	0	3,488	16,119	54,483	60	32,690
Stanislaus River	3,060	0	153	1,346	4,559	100	4,559
Tuolumne River	438	0	22	191	650	100	650
Yuba River	11,615	0	1,162	5,373	18,150	100	18,150
Total	195,553	60,667	46,009	127,037	429,266	NA	239,911

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	120	4,869	998	2,516	8,503	10	850
Sacramento River	7,950	39	1,598	4,029	13,616	92	12,499
Total	8,070	4,908	2,596	6,545	22,118	NA	13,349

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	NA	NA	NA	NA	NA	NA	0
Sacramento River	2,627	388	0	1,262	4,277	90	3,837
Total	2,627	388	0	1,262	4,277	NA	3,837

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	3,616	0	362	1,675	5,652	100	5,652
Deer Creek	830	0	83	385	1,298	100	1,298
Mill Creek	679	0	68	315	1,061	100	1,061
Sacramento River	0	0	0	0	0	100	0
Total	5,125	0	512	2,374	8,011	NA	8,011

2015 Total Adult Chinook Salmon Production = 159,954

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	15,732	9,821	11,499	14,806	51,858	60	31,115
Antelope Creek	6	0	1	3	9	80	8
Battle Creek	3,642	15,712	1,935	8,509	29,798	10	2,980
Bear River	NA	NA	NA	NA	NA	NA	0
Big Chico Creek	NA	NA	NA	NA	NA	NA	0
Butte Creek	82	0	8	36	126	80	101
Clear Creek	8,809	0	881	3,869	13,559	80	10,847
Cosumnes River	204	0	20	86	311	100	311
Cottonwood Creek	604	0	60	267	931	80	745
Cow Creek	591	0	59	259	909	80	728
Deer Creek	612	0	61	267	940	80	752
Feather River	20,566	18,491	7,811	18,725	65,594	60	39,356
Merced River	1,247	1,206	123	1,030	3,606	90	3,245
Mill Creek	1,033	0	103	454	1,590	80	1,272
Miscellaneous Creeks	2	0	0	1	3	80	2
Mokelumne River	4,581	8,298	1,288	5,663	19,830	60	11,898
Paynes Creek	0	0	0	0	0	80	0
Sacramento River	28,660	0	2,866	12,594	44,120	60	26,472
Stanislaus River	6,136	0	307	2,572	9,015	100	9,015
Tuolumne River	113	0	6	50	169	100	169
Yuba River	6,507	0	651	2,860	10,018	100	10,018
Total	99,127	53,528	27,680	72,051	252,386	NA	149,033

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	97	6,827	1,385	3,322	11,630	10	1,163
Sacramento River	2,131	83	443	1,062	3,719	92	3,414
Total	2,228	6,910	1,828	4,384	15,350	NA	4,577

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	NA	NA	NA	NA	NA	NA	0
Sacramento River	3,182	258	0	1,377	4,817	90	4,321
Total	3,182	258	0	1,377	4,817	NA	4,321

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	1,651	0	165	724	2,540	100	2,540
Deer Creek	268	0	27	118	412	100	412
Mill Creek	127	0	13	56	195	100	195
Sacramento River	0	0	0	0	0	100	0
Total	2,046	0	205	897	3,148	NA	3,148

2016 Total Adult Chinook Salmon Production = 160,466

Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
American River	14,473	9,227	10,665	12,886	47,251	60	28,351
Antelope Creek	138	0	14	60	211	80	169
Battle Creek	1,236	8,526	976	4,027	14,765	10	1,477
Bear River	NA	NA	NA	NA	NA	NA	0
Big Chico Creek	NA	NA	NA	NA	NA	NA	0
Butte Creek	83	0	8	36	127	80	102
Clear Creek	2,481	0	248	1,026	3,755	80	3,004
Cosumnes River	1,248	0	125	513	1,886	100	1,886
Cottonwood Creek	813	0	81	334	1,228	80	983
Cow Creek	822	0	82	340	1,244	80	995
Deer Creek	253	0	25	101	380	80	304
Feather River	38,775	20,042	11,763	26,470	97,051	60	58,230
Merced River	2,541	2,996	277	2,178	7,991	90	7,192
Mill Creek	602	0	60	251	913	80	730
Miscellaneous Creeks	32	0	3	12	47	80	38
Mokelumne River	1,984	6,887	887	3,657	13,415	60	8,049
Paynes Creek	8	0	1	6	15	80	12
Sacramento River	4,291	282	457	1,885	6,916	60	4,149
Stanislaus River	9,330	0	466	3,675	13,471	100	13,471
Tuolumne River	1,347	0	67	531	1,945	100	1,945
Yuba River	4,057	0	406	1,676	6,139	100	6,139
Total	84,514	47,960	26,613	59,664	218,752	NA	137,227

Late−Fall Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Battle Creek	57	2,351	482	1,082	3,972	10	397
Sacramento River	3,085	65	630	1,416	5,196	92	4,770
Total	3,142	2,416	1,112	2,498	9,167	NA	5,167

Winter Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Calaveras River	NA	NA	NA	NA	NA	NA	0
Sacramento River	1,409	137	0	577	2,123	90	1,905
Total	1,409	137	0	577	2,123	NA	1,905

Spring Run Chinook Salmon	In−river spawner abundance	Fish entering a hatchery	Estimated in−river harvest	Ocean harvest	Total production	Percent natural production	Natural production
Butte Creek	10,181	0	1,018	4,203	15,402	100	15,402
Deer Creek	331	0	33	137	501	100	501
Mill Creek	175	0	18	72	265	100	265
Sacramento River	0	0	0	0	0	100	0
Total	10,687	0	1,069	4,412	16,168	NA	16,168

5.5 Appendix E: Raw Data Used to Calculate the Young-of-the-Year Index for Juvenile American Shad

↕ Fall Midwater Trawl surveys are conducted during the fall months of September, October, November, and December each year to monitor the abundance of American Shad. These surveys are conducted by the California Department of Fish and Wildlife (CDFW).

Unlike the eight other anadromous fish species that have an AFRP fish production target pertaining to adult fish, the AFRP target for American Shad involves a young-of-the-year (YOY) age class. Because the survey data used to estimate annual shad abundance span a four month period when young shad are actively growing, month-specific fork length size thresholds are used to distinguish between YOY and older shad. The size thresholds used to identify YOY shad are as follows:

Month Fork-Length

Sept. $<$ 150.9 mm

Oct. $<$ 156.9 mm

Nov. $<$ 161.9 mm

Dec. $<$ 164.9 mm

The data used to calculate annual production estimates for YOY American Shad are derived from two files: (1) a CDFW "FMWT AMS Indices 1967-2019.xls" spreadsheet dated January 31, 2020 provides total (YOY plus adult) shad abundance indices for the months of September, October, November, and December each year between 1992 and 2016; and (2) a CDFW "AMS Length Frequency 1971-2019.xls" spreadsheet dated January 31, 2020 provides length frequency data that can be used to determine the percentage of the total catch of American Shad that belong to the YOY age class each month.

Monthly and Annual American Shad Indices ↕

Year	Type	September	October	November	December	Annual
1992	all age abundance index	755	530	463	266	2,014
	adjusted number of fish older than age 0 measured	0	0	0	1	
	adjusted total number of fish measured	565	434	338	136	
	percent YOY	100	100	100	99.3	
	YOY abundance index	755	530	463	264	2,012
1993	all age abundance index	1,972	1,567	908	710	5,157
	adjusted number of fish older than age 0 measured	0	0	0	1.4	
	adjusted total number of fish measured	1515	1228	663	503	
	percent YOY	100	100	100	99.7	
	YOY abundance index	1,972	1,567	908	708	5,155
1994	all age abundance index	439	387	391	117	1,334
	adjusted number of fish older than age 0 measured	5	4	2.2	1	
	adjusted total number of fish measured	345	265	237	72	
	percent YOY	98.6	98.5	99.1	98.6	
	YOY abundance index	433	381	387	115	1,317

Year	Type	September	October	November	December	Annual
1995	all age abundance index	3,246	2,220	791	555	6,812
	adjusted number of fish older than age 0 measured	2.2	1	0	0	
	adjusted total number of fish measured	2584	1760	541	346	
	percent YOY	99.9	99.9	100	100	
	YOY abundance index	3,243	2,219	791	555	6,808
1996	all age abundance index	1,756	1,072	935	523	4,286
	adjusted number of fish older than age 0 measured	1	5	3	2	
	adjusted total number of fish measured	1231	815	604	324	
	percent YOY	99.9	99.4	99.5	99.4	
	YOY abundance index	1,755	1,065	930	520	4,270
1997	all age abundance index	265	565	639	1,125	2,594
	adjusted number of fish older than age 0 measured	2	1	0	0	
	adjusted total number of fish measured	198	458	503	774	
	percent YOY	99	99.8	100	100	
	YOY abundance index	262	564	639	1,125	2,590
1998	all age abundance index	1,318	2,093	515	214	4,140
	adjusted number of fish older than age 0 measured	0	0	2	0	
	adjusted total number of fish measured	989	1554	347	111	
	percent YOY	100	100	99.4	100	
	YOY abundance index	1,318	2,093	512	214	4,137
1999	all age abundance index	346	155	145	69	715
	adjusted number of fish older than age 0 measured	0	0	0	0	
	adjusted total number of fish measured	273	133	118	41	
	percent YOY	100	100	100	100	
	YOY abundance index	346	155	145	69	715
2000	all age abundance index	253	326	126	59	764
	adjusted number of fish older than age 0 measured	0	0	0	0	
	adjusted total number of fish measured	166	255	79	41	
	percent YOY	100	100	100	100	
	YOY abundance index	253	326	126	59	764
2001	all age abundance index	338	239	110	78	765
	adjusted number of fish older than age 0 measured	0	0	0	1	
	adjusted total number of fish measured	259	188	96	42	
	percent YOY	100	100	100	97.6	
	YOY abundance index	338	239	110	76	763

Year	Type	September	October	November	December	Annual
2002	all age abundance index	372	832	334	382	1,920
	adjusted number of fish older than age 0 measured	1	1	0	1	
	adjusted total number of fish measured	293	648	206	237	
	percent YOY	99.7	99.8	100	99.6	
	YOY abundance index	371	831	334	380	1,916
2003	all age abundance index	3,345	2,947	1,279	1,789	9,360
	adjusted number of fish older than age 0 measured	2.7	1	0	0	
	adjusted total number of fish measured	2391	2224	996	1098	
	percent YOY	99.9	100	100	100	
	YOY abundance index	3,341	2,946	1,279	1,789	9,355
2004	all age abundance index	680	83	78	106	947
	adjusted number of fish older than age 0 measured	0	0	0	0	
	adjusted total number of fish measured	577	68	65	66	
	percent YOY	100	100	100	100	
	YOY abundance index	680	83	78	106	947
2005	all age abundance index	826	552	177	189	1,744
	adjusted number of fish older than age 0 measured	1	0	0	0	
	adjusted total number of fish measured	344	398	141	123	
	percent YOY	99.7	100	100	100	
	YOY abundance index	824	552	177	189	1,742
2006	all age abundance index	1,119	142	646	406	2,313
	adjusted number of fish older than age 0 measured	3.8	0	2	1	
	adjusted total number of fish measured	881	87	522	235	
	percent YOY	99.6	100	99.6	99.6	
	YOY abundance index	1,114	142	644	404	2,304
2007	all age abundance index	123	257	116	57	553
	adjusted number of fish older than age 0 measured	0	1	0	0	
	adjusted total number of fish measured	112	216	90	48	
	percent YOY	100	99.5	100	100	
	YOY abundance index	123	256	116	57	552
2008	all age abundance index	14	25	19	213	271
	adjusted number of fish older than age 0 measured	0	0	0	0	
	adjusted total number of fish measured	12	20	13	153	
	percent YOY	100	100	100	100	
	YOY abundance index	14	25	19	213	271

Year	Type	September	October	November	December	Annual
2009	all age abundance index	81	75	252	216	624
	adjusted number of fish older than age 0 measured	0	0	0	0	
	adjusted total number of fish measured	59	35	192	153	
	percent YOY	100	100	100	100	
	YOY abundance index	81	75	252	216	624
2010	all age abundance index	130	54	114	385	683
	adjusted number of fish older than age 0 measured	0	0	0	0	
	adjusted total number of fish measured	109	31	80	189	
	percent YOY	100	100	100	100	
	YOY abundance index	130	54	114	385	683
2011	all age abundance index	413	204	142	135	894
	adjusted number of fish older than age 0 measured	0	0	0	0	
	adjusted total number of fish measured	306	175	82	74	
	percent YOY	100	100	100	100	
	YOY abundance index	413	204	142	135	894
2012	all age abundance index	135	141	34	105	415
	adjusted number of fish older than age 0 measured	0	1	0	0	
	adjusted total number of fish measured	110	95	33	63	
	percent YOY	100	98.9	100	100	
	YOY abundance index	135	140	34	105	414
2013	all age abundance index	74	61	86	88	309
	adjusted number of fish older than age 0 measured	0	0	0	0	
	adjusted total number of fish measured	63	48	63	57	
	percent YOY	100	100	100	100	
	YOY abundance index	74	61	86	88	309
2014	all age abundance index	46	17	72	143	278
	adjusted number of fish older than age 0 measured	0	0	0	0	
	adjusted total number of fish measured	39	16	61	117	
	percent YOY	100	100	100	100	
	YOY abundance index	46	17	72	143	278
2015	all age abundance index	6	12	22	39	79
	adjusted number of fish older than age 0 measured	0	0	0	0	
	adjusted total number of fish measured	6	10	19	24	
	percent YOY	100	100	100	100	
	YOY abundance index	6	12	22	39	79

Year	Type	September	October	November	December	Annual
2016	all age abundance index	61	67	117	68	313
	adjusted number of fish older than age 0 measured	0	0	0	0	
	adjusted total number of fish measured	58	38	100	53	
	percent YOY	100	100	100	100	
	YOY abundance index	61	67	117	68	313

5.6 Appendix F: Adult Chinook Salmon Escapement Tables and Graphs Based On a Cormack-Jolly-Seber Mark Recapture Model

The data in the graphs below are based on analyses that utilize a super-population modification of a Cormack-Jolly-Seber mark recapture model. The error bars represent the upper and lower bounds of 90 % confidence intervals unless otherwise noted in the graphs.

Data for 2016 should be considered to be provisional and subject to possible revision. For the graph displaying Spring-run Chinook Salmon video camera data from the Yuba River, there are no error bars because the video cameras at that site have worked successfully on a continuous basis since the beginning of 2011, i.e., the point estimates reflect complete, accurate counts of the salmon passing by the camera and no error bars are necessary.

Blank cells in the tables represent periods when data are not available at the time of report production.

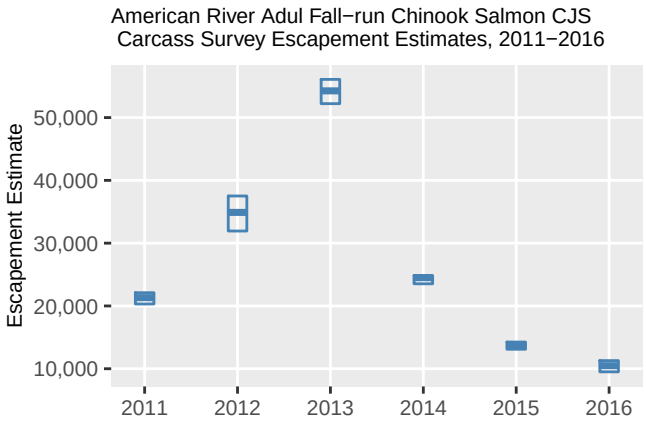
year	survey_type	watershed	salmon_run	point_estimate	lower	upper
2011	carcass survey	American River	fall−run Chinook salmon	21,320	20,312	22,109
2012	carcass survey	American River	fall−run Chinook salmon	34,900	31,933	37,513
2013	carcass survey	American River	fall−run Chinook salmon	54,259	52,221	56,083
2014	carcass survey	American River	fall−run Chinook salmon	24,503	23,529	24,843
2015	carcass survey	American River	fall−run Chinook salmon	13,793	13,106	14,251
2016	carcass survey	American River	fall−run Chinook salmon	10,484	9,510	11,295
2011	video camera	Battle Creek	fall−run Chinook salmon	54,895	52,109	57,858
2012	video camera	Battle Creek	fall−run Chinook salmon	116,847	108,848	125,907
2013	video camera	Battle Creek	fall−run Chinook salmon	101,548	94,524	108,413
2014	video camera	Battle Creek	fall−run Chinook salmon	45,596	39,185	51,668
2015	video camera	Battle Creek	fall−run Chinook salmon	19,355	18,151	20,529
2016	video camera	Battle Creek	fall−run Chinook salmon	9,762	8,919	10,642
2011	carcass survey	Butte Creek	fall−run Chinook salmon	416	284	607
2012	carcass survey	Butte Creek	fall−run Chinook salmon	813	423	NA
2013	carcass survey	Butte Creek	fall−run Chinook salmon	2,200	2,005	2,457
2014	carcass survey	Butte Creek	fall−run Chinook salmon	1,412	1,165	1,837
**2015	carcass survey	Butte Creek	fall−run Chinook salmon	82	NA	NA
2016	carcass survey	Butte Creek	fall−run Chinook salmon	NA	NA	NA
2011	carcass survey	Butte Creek	spring−run Chinook salmon	4,859	4,268	NA
2012	carcass survey	Butte Creek	spring−run Chinook salmon	16,140	15,806	16,885
2013	carcass survey	Butte Creek	spring−run Chinook salmon	15,887	15,400	16,477
2014	carcass survey	Butte Creek	spring−run Chinook salmon	4,851	4,461	5,310
2015	carcass survey	Butte Creek	spring−run Chinook salmon	413	329	575
2016	carcass survey	Butte Creek	spring−run Chinook salmon	7,528	6,220	8,788
2011	carcass survey	Clear Creek	fall−run Chinook salmon	4,841	4,596	5,106
2012	carcass survey	Clear Creek	fall−run Chinook salmon	7,631	7,047	8,215
2013	carcass survey	Clear Creek	fall−run Chinook salmon	13,337	12,429	14,246
2014	video camera	Clear Creek	fall−run Chinook salmon	15,794	14,672	16,992
2015	video camera	Clear Creek	fall−run Chinook salmon	8,809	8,291	9,334
2016	video camera	Clear Creek	fall−run Chinook salmon	2,481	2,171	2,791
2011	video camera	Cottonwood Creek	fall−run Chinook salmon	2,144	2,038	2,250
2012	video camera	Cottonwood Creek	fall−run Chinook salmon	2,556	2,333	2,812
2013	video camera	Cottonwood Creek	fall−run Chinook salmon	2,774	2,304	2,971
2014	video camera	Cottonwood Creek	fall−run Chinook salmon	1,940	1,789	2,088
2015	video camera	Cottonwood Creek	fall−run Chinook salmon	604	536	675
2016	video camera	Cottonwood Creek	fall−run Chinook salmon	813	720	954
2011	video camera	Cow Creek	fall−run Chinook salmon	1,617	1,442	1,747
2012	video camera	Cow Creek	fall−run Chinook salmon	1,488	1,195	1,818

** Total number of salmon observed with a Vaki Riverwatcher, carcass survey, and anecdotal visual encounters by field crew members.

year	survey_type	watershed	salmon_run	point_estimate	lower	upper
2013	video camera	Cow Creek	fall−run Chinook salmon	3,011	2,663	3,326
2014	video camera	Cow Creek	fall−run Chinook salmon	3,535	3,097	4,081
2015	video camera	Cow Creek	fall−run Chinook salmon	591	507	653
2016	video camera	Cow Creek	fall−run Chinook salmon	822	680	1,071
2014	video camera/redds	Deer Creek	fall−run Chinook salmon	849	771	984
***2015	video camera/redds	Deer Creek	fall−run Chinook salmon	612	NA	NA
2016	video camera/redds	Deer Creek	fall−run Chinook salmon	253	155	328
2014	video camera	Deer Creek	spring−run Chinook salmon	830	732	923
***2015	video camera	Deer Creek	spring−run Chinook salmon	268	NA	NA
2016	video camera	Deer Creek	spring−run Chinook salmon	331	286	1,854
2011	carcass survey	Feather River	fall and spring−run Chinook salmon combined	47,289	46,337	48,342
2012	carcass survey	Feather River	fall and spring−run Chinook salmon combined	63,648	62,842	64,503
***2013	carcass survey	Feather River	fall and spring−run Chinook salmon combined	151,209	NA	NA
*2014	carcass survey	Feather River	fall and spring−run Chinook salmon combined	60,721	59,313	62,022
***2015	carcass survey	Feather River	fall and spring−run Chinook salmon combined	20,271	20,042	20,562
2016	carcass survey	Feather River	fall and spring−run Chinook salmon combined	38,781	38,280	39,385
2011	carcass survey	Merced River	fall−run Chinook salmon	1,615	1,473	1,811
2012	carcass survey	Merced River	fall−run Chinook salmon	2,257	2,119	3,436
2013	carcass survey	Merced River	fall−run Chinook salmon	2,865	2,564	3,150
2014	carcass survey	Merced River	fall−run Chinook salmon	863	633	1,494
2015	carcass survey	Merced River	fall−run Chinook salmon	1,247	1,063	1,484
2016	carcass survey	Merced River	fall−run Chinook salmon	3,328	3,001	3,669
2011	video camera	Mill Creek	fall−run Chinook salmon	1,485	1,068	1,610
2012	video camera	Mill Creek	fall−run Chinook salmon	823	724	1,611
2013	video camera	Mill Creek	fall−run Chinook salmon	2,197	2,033	2,468
2014	video camera	Mill Creek	fall−run Chinook salmon	2,488	2,276	2,745
2015	video camera	Mill Creek	fall−run Chinook salmon	968	925	1,142
2016	video camera	Mill Creek	fall−run Chinook salmon	602	547	652
2013	video camera	Mill Creek	spring−run Chinook salmon	644	573	716
2014	video camera	Mill Creek	spring−run Chinook salmon	679	619	742
2015	video camera	Mill Creek	spring−run Chinook salmon	127	104	150
2016	video camera	Mill Creek	spring−run Chinook salmon	175	150	201
2011	carcass survey	Sacramento River	fall−run Chinook salmon	11,592	10,056	13,126
2012	carcass survey	Sacramento River	fall−run Chinook salmon	28,701	26,527	30,875
2013	carcass survey	Sacramento River	fall−run Chinook salmon	40,084	37,197	42,972
2014	carcass survey	Sacramento River	fall−run Chinook salmon	35,014	25,343	44,684

year	survey_type	watershed	salmon_run	point_estimate	lower	upper
2015	carcass survey	Sacramento River	fall−run Chinook salmon	28,659	25,649	31,669
2016	carcass survey	Sacramento River	fall−run Chinook salmon	4,517	3,267	5,875
***2011	carcass survey	Sacramento River	winter−run Chinook salmon	824	NA	NA
2012	carcass survey	Sacramento River	winter−run Chinook salmon	2,674	2,451	2,896
2013	carcass survey	Sacramento River	winter−run Chinook salmon	6,404	5,710	7,099
2014	carcass survey	Sacramento River	winter−run Chinook salmon	3,015	2,741	3,290
2015	carcass survey	Sacramento River	winter−run Chinook salmon	3,439	3,042	3,836
2016	carcass survey	Sacramento River	winter−run Chinook salmon	1,546	329	2,763
***2011	carcass survey	Sacramento River	late fall−run Chinook salmon	3,725	NA	NA
2012	carcass survey	Sacramento River	late fall−run Chinook salmon	2,869	2,468	3,175
2013	carcass survey	Sacramento River	late fall−run Chinook salmon	5,267	825	13,545
2014	carcass survey	Sacramento River	late fall−run Chinook salmon	7,988	6,775	9,201
2015	carcass survey	Sacramento River	late fall−run Chinook salmon	2,222	0	4,780
2016	carcass survey	Sacramento River	late fall−run Chinook salmon	3,150	2,373	3,927
2011	carcass survey	Stanislaus River	fall−run Chinook salmon	1,063	1,010	1,120
2012	carcass survey	Stanislaus River	fall−run Chinook salmon	4,006	3,746	4,322
2013	carcass survey	Stanislaus River	fall−run Chinook salmon	2,858	2,729	2,999
2014	carcass survey	Stanislaus River	fall−run Chinook salmon	3,064	2,770	3,484
2015	carcass survey	Stanislaus River	fall−run Chinook salmon	6,136	5,580	6,724
2016	carcass survey	Stanislaus River	fall−run Chinook salmon	9,482	8,878	10,332
2011	carcass survey	Tuolumne River	fall−run Chinook salmon	878	856	900
2012	carcass survey	Tuolumne River	fall−run Chinook salmon	789	740	804
2013	carcass survey	Tuolumne River	fall−run Chinook salmon	1,958	1,934	1,988
2014	carcass survey	Tuolumne River	fall−run Chinook salmon	206	155	285
2015	carcass survey	Tuolumne River	fall−run Chinook salmon	113	55	223
2016	carcass survey	Tuolumne River	fall−run Chinook salmon	1,360	1,318	1,396
2011	VAKI + carcass survey	Yuba River	fall−run Chinook salmon	8,024	7,907	8,098
2012	VAKI + carcass survey	Yuba River	fall−run Chinook salmon	6,287	6,205	6,379
2013	VAKI + carcass survey	Yuba River	fall−run Chinook salmon	11,872	11,705	12,062
2014	VAKI + carcass survey	Yuba River	fall−run Chinook salmon	9,657	9,499	9,892
2011	VAKI	Yuba River	spring−run Chinook salmon	1,159	1,159	1,159
2012	VAKI	Yuba River	spring−run Chinook salmon	1,046	1,046	1,046
2013	VAKI	Yuba River	spring−run Chinook salmon	3,130	3,130	3,130
2014	VAKI	Yuba River	spring−run Chinook salmon	2,336	2,336	2,336

NA = no data available * 95% confidence intervals *** no confidence intervals developed.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30,000
20,000
10,000
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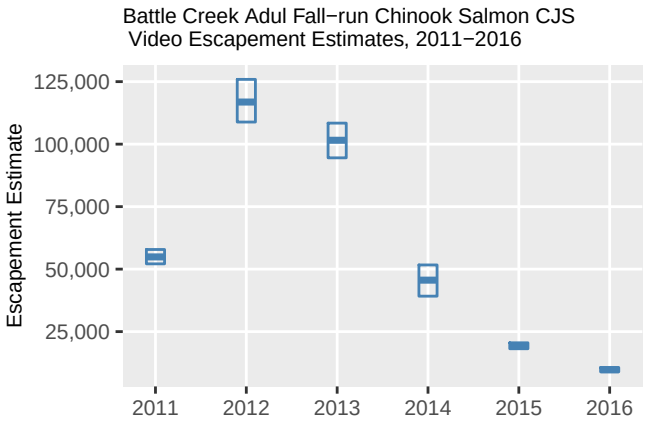
2012
2013
2014
2015
2016


Battle Creek Adul Fall−run Chinook Salmon CJS
Video Escapement Estimates, 2011−2016
Escapement Estimate
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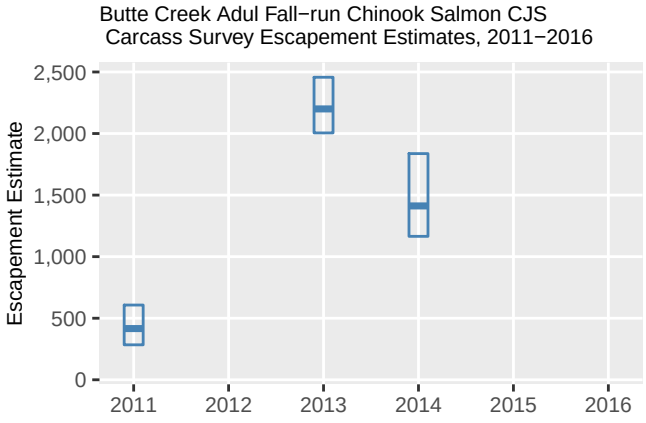
25,000
2011
2012
2013
2014
2015
2016


Butte Creek Adul Fall−run Chinook Salmon CJS
Carcass Survey Escapement Estimates, 2011−2016
Escapement Estimate
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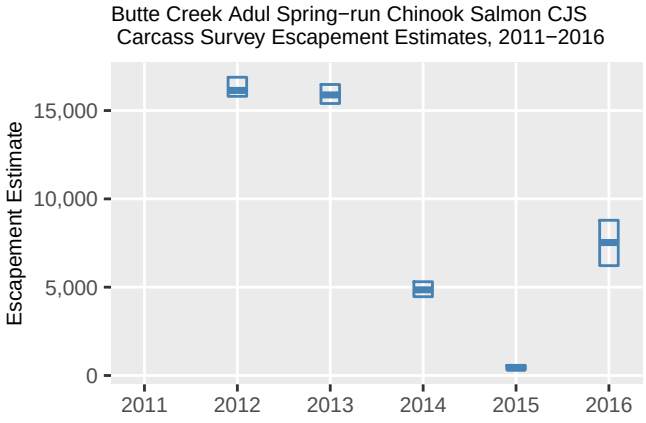
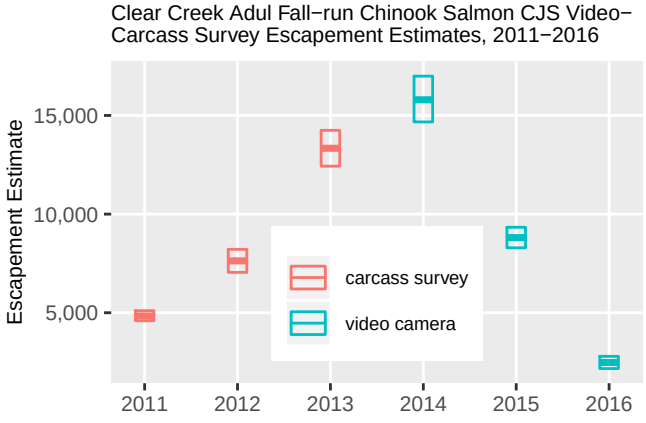
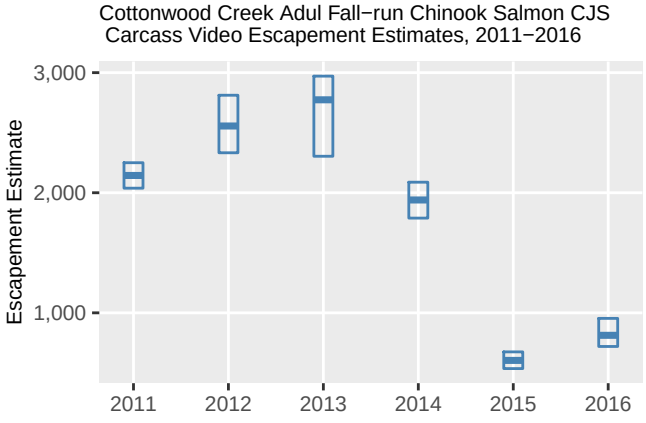
2,000
1,500
1,000
500
0
2011
2012
2013
2014
2015
2016


Butte Creek Adul Spring−run Chinook Salmon CJS
Carcass Survey Escapement Estimates, 2011−2016
Escapement Estimate
15,000
10,000
5,000
0
2011
2012
2013
2014
2015
2016


Clear Creek Adul Fall−run Chinook Salmon CJS Video−
Carcass Survey Escapement Estimates, 2011−2016
Escapement Estimate
15,000
10,000
5,000
carcass survey
video camera
2011
2012
2013
2014
2015
2016


Cottonwood Creek Adul Fall−run Chinook Salmon CJS
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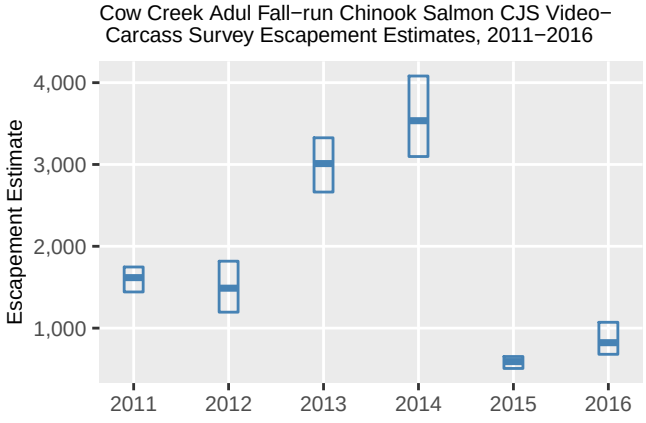
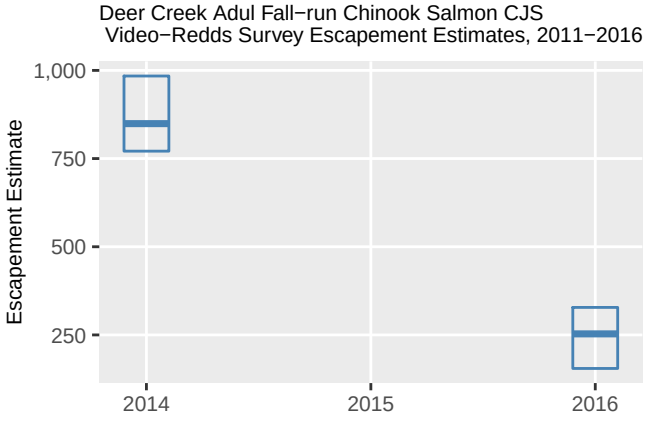
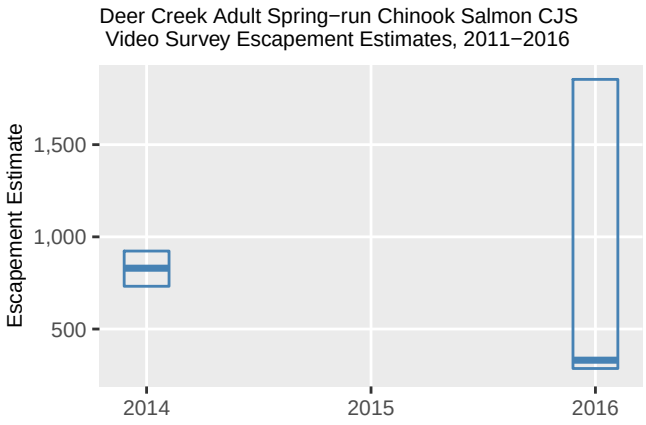
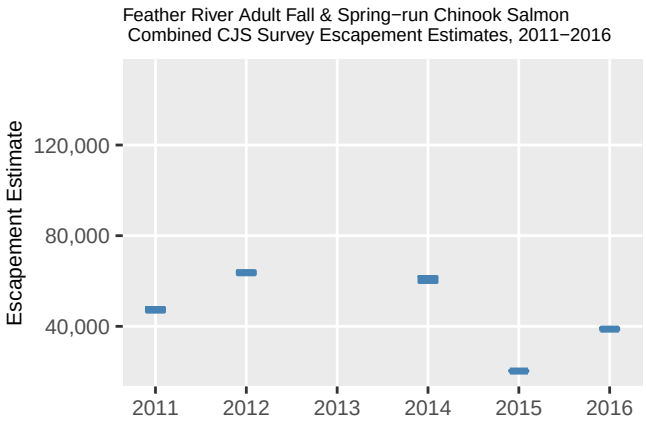
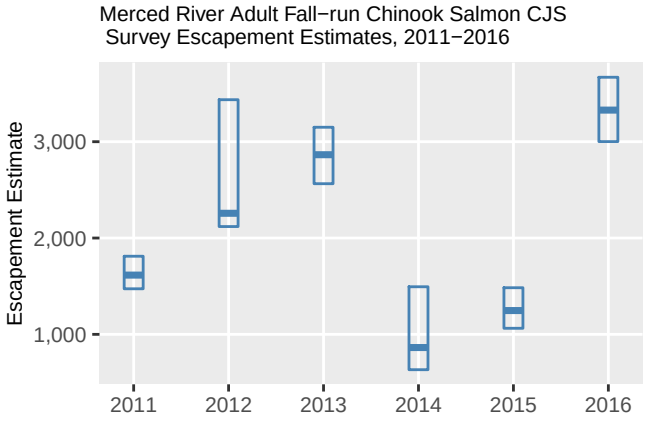
3,000
2,000
1,000
2011
2012
2013
2014
2015
2016

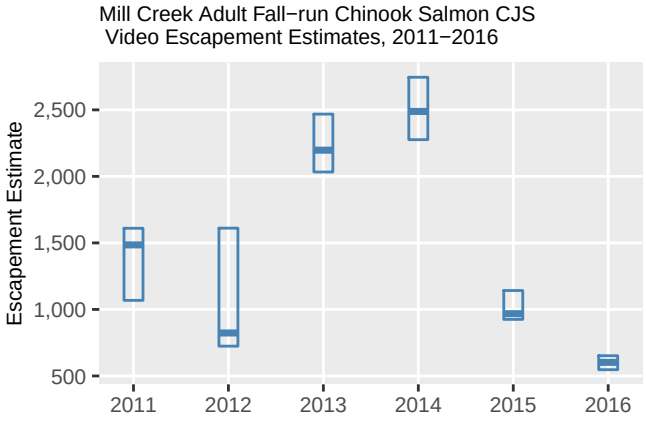

Cow Creek Adul Fall−run Chinook Salmon CJS Video−
Carcass Survey Escapement Estimates, 2011−2016
Escapement Estimate
4,000
3,000
2,000
1,000
2011
2012
2013
2014
2015
2016

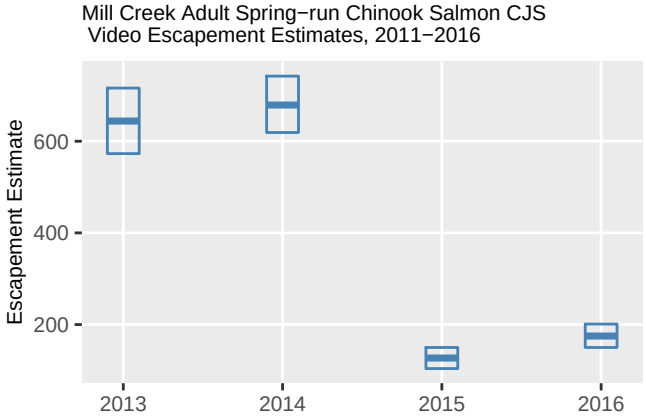

Deer Creek Adul Fall−run Chinook Salmon CJS
Video−Redds Survey Escapement Estimates, 2011−2016
Escapement Estimate
1,000
750
500
250
2014
2015
2016

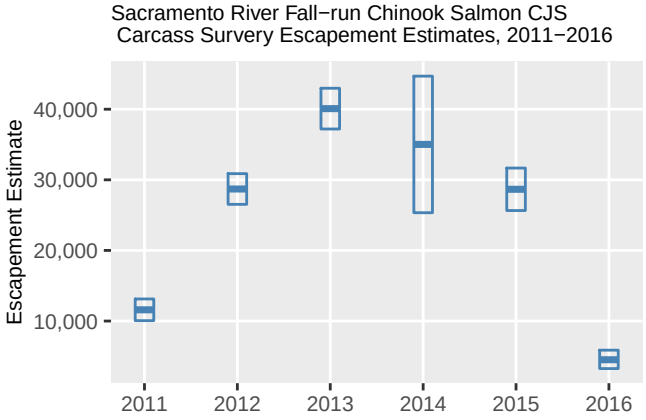

Deer Creek Adult Spring−run Chinook Salmon CJS
Video Survey Escapement Estimates, 2011−2016
Escapement Estimate
1,500
1,000
500
2014
2015
2016

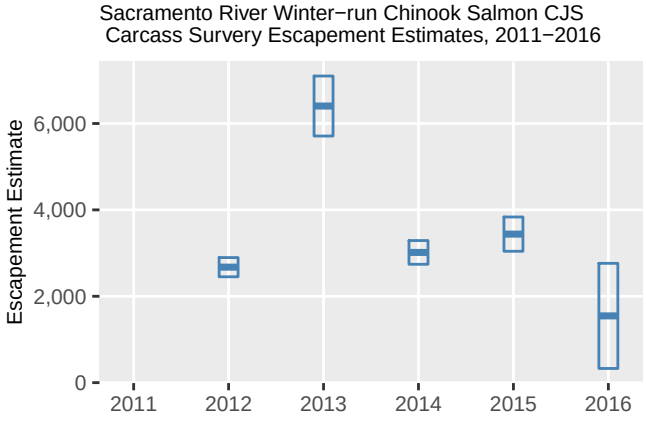

Feather River Adult Fall & Spring−run Chinook Salmon
Combined CJS Survey Escapement Estimates, 2011−2016
Escapement Estimate
120,000
80,000
40,000
2011
2012
2013
2014
2015
2016

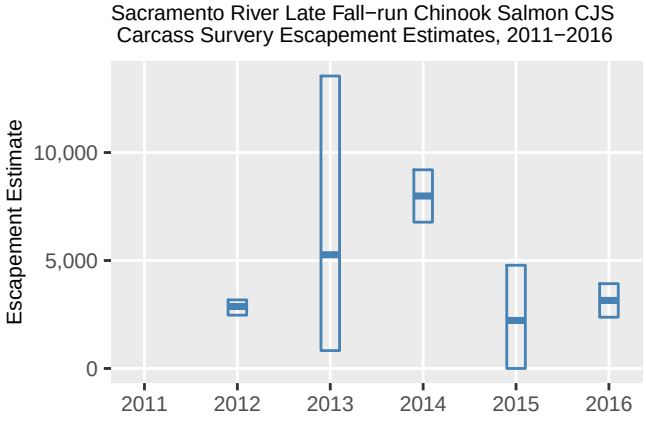

Merced River Adult Fall−run Chinook Salmon CJS
Survey Escapement Estimates, 2011−2016
Escapement Estimate
3,000
2,000
1,000
2011
2012
2013
2014
2015
2016

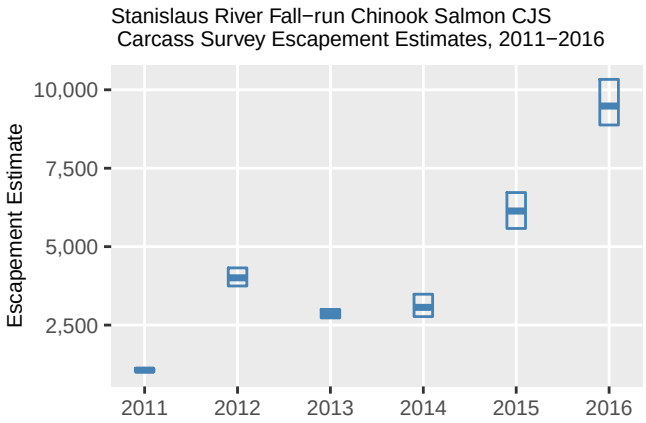

Mill Creek Adult Fall−run Chinook Salmon CJS
Video Escapement Estimates, 2011−2016
Escapement Estimate
2,500
2,000
1,500
1,000
500
2011
2012
2013
2014
2015
2016

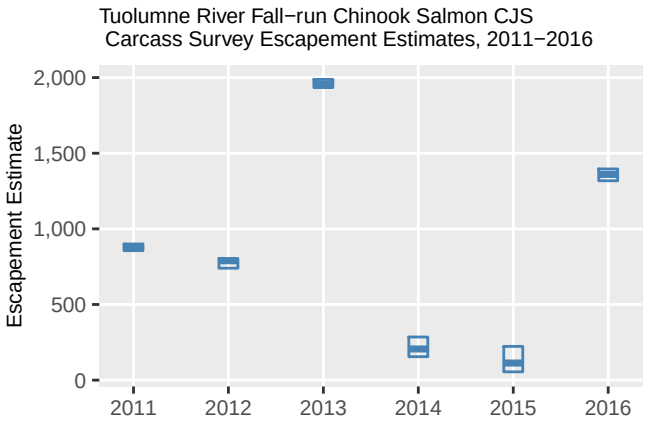

Mill Creek Adult Spring−run Chinook Salmon CJS
Video Escapement Estimates, 2011−2016
Escapement Estimate
600
400
200
2013
2014
2015
2016

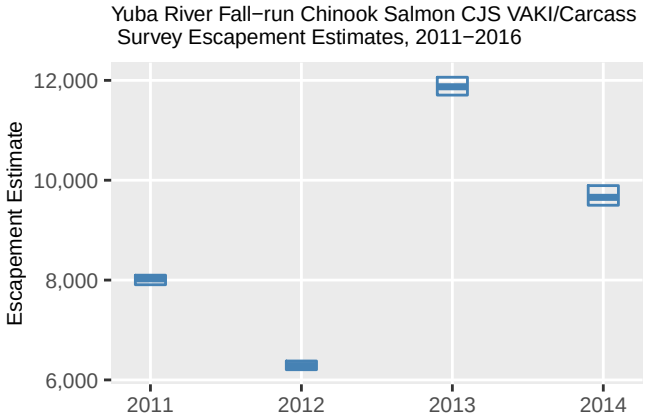

Sacramento River Fall−run Chinook Salmon CJS
Carcass Survery Escapement Estimates, 2011−2016
Escapement Estimate
40,000
30,000
20,000
10,000
2011
2012
2013
2014
2015
2016

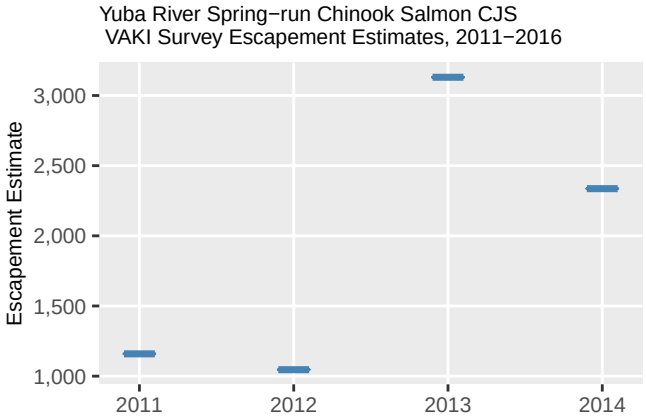

Sacramento River Winter−run Chinook Salmon CJS
Carcass Survery Escapement Estimates, 2011−2016
Escapement Estimate
6,000
4,000
2,000
0
2011
2012
2013
2014
2015
2016


Sacramento River Late Fall−run Chinook Salmon CJS
Carcass Survery Escapement Estimates, 2011−2016
Escapement Estimate
10,000
5,000
0
2011
2012
2013
2014
2015
2016


Stanislaus River Fall−run Chinook Salmon CJS
Carcass Survey Escapement Estimates, 2011−2016
Escapement Estimate
10,000
7,500
5,000
2,500
2011
2012
2013
2014
2015
2016


Tuolumne River Fall−run Chinook Salmon CJS
Carcass Survey Escapement Estimates, 2011−2016
Escapement Estimate
2,000
1,500
1,000
500
0
2011
2012
2013
2014
2015
2016


Yuba River Fall−run Chinook Salmon CJS VAKI/Carcass
Survey Escapement Estimates, 2011−2016
Escapement Estimate
12,000
10,000
8,000
6,000
2011
2012
2013
2014


Yuba River Spring−run Chinook Salmon CJS
VAKI Survey Escapement Estimates, 2011−2016
Escapement Estimate
3,000
2,500
2,000
1,500
1,000
2011
2012
2013
2014

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